

[ESTABLISHED 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

# AMERICAN ENGINEER

AND  
RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE, INC.  
140 NASSAU STREET, NEW YORK

J. S. BONSALE, Vice-President and General Manager

F. H. THOMPSON, Advertising Manager.

Editors:

E. A. AVERILL.

OSCAR KUENZEL.

OCTOBER, 1910

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## ALL STEEL PASSENGER CARS

Steel car designers will be interested in studying the features of the underframe designed by the Pullman Co., which is shown in this issue. By a careful study this company has been able to develop a steel underframe which is not unduly heavy and is still perfectly suited and entirely interchangeable between practically all types of passenger cars.

It will be seen that this standard design is arranged to carry practically all of the load and transmit all buffing and pulling shocks through a large centre girder, being in this respect somewhat similar to the construction employed in the Pennsylvania steel car. The use of the large combination casting at the ends simplifies the whole design decidedly, although it would appear as if too many parts were included in this one casting. There would seem to be no objection to forming those parts, which are more liable to become damaged, separately and bolt them to the main casting. In other respects the design presents practically nothing to criticize.

In the superstructure special efforts have been made to insure excellent insulation. This feature is a particularly important one on sleeping cars, and it is to be hoped that the schemes here employed will prove satisfactory in very cold weather.

While the designers of this car are to be congratulated in respect to its total weight it is quite probable that longer experience will bring out a number of points wherein they can be made still lighter. It is to be hoped that these steel cars will eventually weigh no more than the present wooden ones.

## CONVERTED MALLET LOCOMOTIVE

About a year ago the Great Northern Railroad transformed a large consolidation locomotive into a Mallet compound engine simply by the addition of a new front group of wheels with a low pressure cylinder and an extension on the boiler, which contains a feed water heater. At the same time a high degree superheater was installed in the old boiler. In other respects the original boiler, as far as the steam generating section was concerned, was not altered. This new locomotive was put into service on the same section where the original consolidation was used, and the result is that by burning practically the same amount of coal about 50 per cent. greater tonnage is moved over the road. There is nothing particularly surprising in this result, which only checks the figures which have been obtained previously in other comparisons, but the interesting part is in the small cost at which this largely increased tonnage was obtained.

## GENERAL EFFICIENCY

During the past few years there has been a remarkable advance in the design and construction of machine tools, and especially of those for use in railroad shops. However, this is but an instance of the future general improvement resulting from the heavier demands continually being made upon tool manufacturers by industrial as well as railroad shop people. This has already resulted in astonishingly high efficiencies which were never anticipated, even by the makers. It is only fair, however, to give a large part of this credit to the manufacturers of high speed steel who have made equally, or perhaps even more, remarkable progress. In fact, it is safe to say that the progress made in the design and construction of machine tools was, in a way, the result of the great advance that had been made in high speed cutting tools, and machine builders were influenced not only by the demands of the users of their products, but also by the necessity to keep pace with the rapid advance and improvement in the manufacture of high speed steel. Even at the present time, with the best designed modern machine tools it is doubtful if the full

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advantages of high speed steel are always being utilized or the great possibilities in efficiency completely realized.

The reduced operating cost of many railroad machine shops is undoubtedly due in a large measure to the activity and talent of machine tool builders and to the steel makers, but it is impossible to foretell the result in efficiency of a plant where we have a proper combination of machine tool efficiency or individual efficiency with rapid shop facilities and methods and also an efficient management. High individual efficiency is very rapidly reduced when the work is not planned properly or when there is a lack of proper facilities for handling material. The high total efficiency in output (of a shop) that could be realized with only a small amount of attention to planning the work properly and providing facilities, would be very surprising and much more than is usually supposed.

Probably one of the largest factors in the total efficiency of a shop is the proper location of tools or grouping of tools both to aid supervision and to save unnecessary handling of material. In addition to this, the proper output of machine tools and methods for obtaining this have a decided effect upon the establishment of the proper labor compensation which in turn has a direct bearing on the resulting general efficiency.

In many railroad shops, when a machinist becomes efficient after performing a number of repeated operations, his reward is sometimes a "cut" in the price on that particular work by the foreman of the department. As a result the machinist refuses to increase his efficiency further and he puts himself in the same class with the less skilled machinist, being practically forced to take this course by the management. This reduction of the efficiency of the good machinist has a depressing effect upon the general output of the shop, and many foremen do not realize that in cutting prices unnecessarily they are bound to reduce the output, possibly to a greater extent than the saving made by the cut, to say nothing of the ill feeling and discontent which must follow such actions, completely destroying all co-operation between the men and the foremen, and frequently also resulting in a variety of schemes on the part of the men to cheat the company out of all the time they possibly can.

The cause of this more or less general condition is principally a sad lack of knowledge in superintendents and foremen, of what should be a proper and reasonable output to demand from the men under various conditions. It is very unfortunate that there is a general lack of reliable information and data on this question and more especially on methods for arriving at this output.

## Low Water Test of a Jacobs-Schupert Fire Box

WITH THE WATER LEVEL FROM 4 TO 6 IN. BELOW THE TOP OF THE CROWN SHEET, OIL BURNER GOING FULL BLAST, STEAM PRESSURE OF ABOUT 230 LBS., AND A TEMPERATURE OF THE CROWN SHEET AT OVER 1100 DEGS., A BOILER WITH A JACOBS-SCHUPERT FIRE BOX WAS FILLED WITH WATER AT 60 DEGS. TEMPERATURE IN A RECENT TEST.

In the presence of a number of the mechanical officials of the Santa Fe Railroad, boiler inspectors, representatives of the Brotherhood of Locomotive Engineers and E. L. Gibbs, safety appliance inspector of the Interstate Commerce Commission, a test was made on September 26th to determine the effect of low water on a Jacobs-Schupert fire box.\*

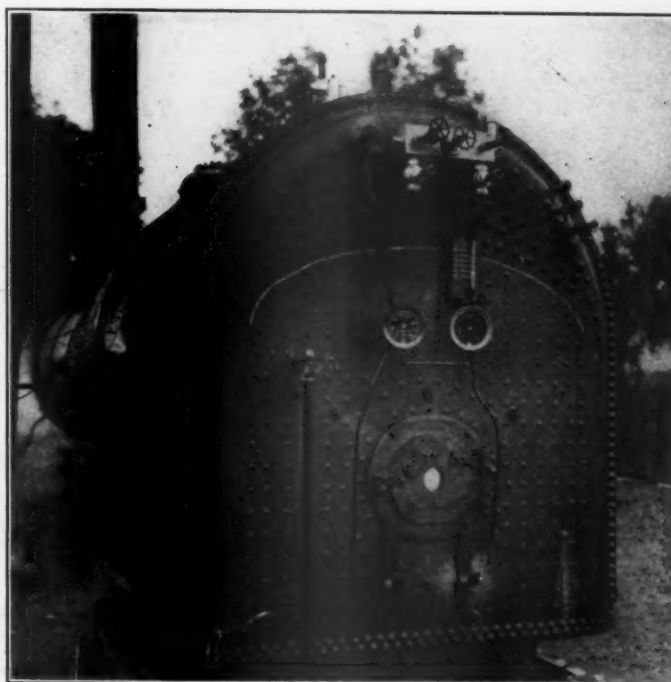
The boiler was of the standard design used on the Santa Fe type locomotives and had been in service in the stationary plant for about ten months. It was carefully mounted in an open space in the shop yard and equipped for burning oil. The oil burning equipment and other boiler appliances were the same as is used in regular locomotive service. In place of injectors a steam pump was connected for furnishing the feed water, this pump being located some distance from the boiler and operated by steam from the stationary plant, so that in case of anything happening to the boiler there would be no danger to the operator of the pump. The blow-off cock located in the front water leg was provided with apparatus so that it could be opened and closed from a safe distance. The supply of oil for the burner was also controlled from the same place.

On the back head of the boiler a line was drawn corresponding to the height and contour of the crown sheet, and in addition to the usual water glass a second water glass was placed at such a height that its top was level with the bottom of the other one. Behind this glass was a scale marked with large figures, which showed the distance of the level below the top of the crown sheet.

Pyrometers were arranged to indicate the temperature on the water side of the crown sheet and connections were made for the proper reading of the instruments in a thoroughly protected location near by. The steam gauges and water glasses were also visible from this same protected spot and here were stationed the spectators. A telescope permitted the accurate reading of the steam gauge and the water level.

The boiler was fired up in the usual manner and after the safety valves, which were set at 225 lbs. pressure, opened, the

blow-off cock was opened with the fire still burning, and level of the water was lowered to a point 4 in. below the crown sheet. The blow-off cock was then closed, and the boiler remained in this condition for ten minutes with the oil burner operating at full pressure. During this time the safety valves were still blowing off and the evaporation brought the level down to 6 in. below the crown at the end of the test. The average steam pressure shown at the gauge during this time was 230 lbs. At the end of ten minutes the feed pump was started, the fire extinguished and water of 60 degrees temperature was pumped into the boiler, the pumping being continued until there was two-

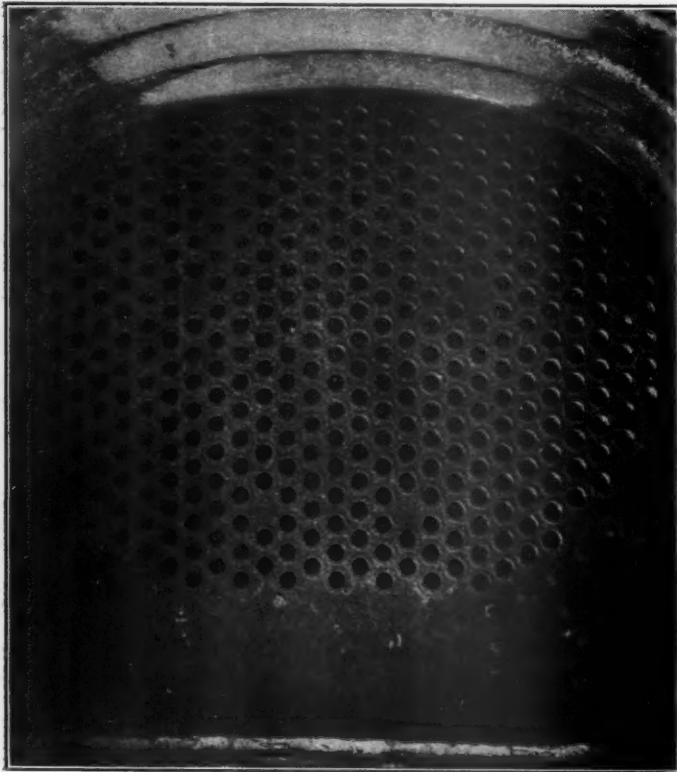


BOILER READY FOR LOW WATER TEST.

\* For full illustrated description of this design See AMERICAN ENGINEER, March, 1909, p. 106.

thirds of a glass on the upper or regular water glass.

At the time the cold water was started the pyrometer registered 1,125 degrees at the front end of the fire box and 1,065 at



INTERIOR OF FIREBOX AFTER LOW WATER TEST. THE TUBES ARE WELDED IN THE SHEET BY THE AUTOGENEOUS PROCESS.

the rear end. Immediately after the test and while there was still steam pressure in the boiler several boiler inspectors entered the fire box and examined it closely. As is seen in the illustration, the photograph for which was taken immediately after the test, there is plain evidence of the metal having been heated to an exceedingly high temperature, but there is no sign of deformation, no bulging being evident, and the fire box as a whole was found to be in practically perfect condition.

This test reproduced the most severe treatment possible for a locomotive boiler and one under which the ordinary stay supported crown sheet would have undoubtedly failed. In addition to proving the superiority, under these conditions, of a fire box which employs no stay bolts it also checks the tests made a number of years ago by the Pennsylvania Railroad, in showing that there is no danger of explosion by putting cold water on to fire box sheets which have been overheated.

#### WHEEL ARRANGEMENT AND WHEEL STRESSES ON MALLETT LOCOMOTIVES.

To the Editor:

In the first paragraph of the article on the Equalization of Mallet Articulated Locomotives, in your September issue, Mr. Johnston states that the practice of equalizing "all the driving springs of the front engine with the leading truck, if one is used, prevents local stresses of a diagonal nature on uneven track, or when entering or leaving curves on which the outer rail is elevated."

It would be interesting if the writer would state the observations upon which this statement is based. The eye is hardly accurate or quick enough to be reliable, and, in my own work, I have found that mathematical calculations based upon assumptions of behaviors of centers of gravity and wheel arrangements are the quintessence of unreliability.

GEO. L. FOWLER.

NEW YORK.

#### GOULD AND EBERHARDT'S APPRENTICESHIP SYSTEM

At the last convention of the National Machine Tool Builders' Association, Fred L. Eberhardt, president of the Gould and Eberhardt Company, Newark, N. J., presented a paper on the apprenticeship system in use at that plant.

He stated that applicants were obtained by applying to the superintendents of public schools and the technical schools, Municipal Bureau of Labor and by advertising in the daily papers. These advertisements appeal first to the boys themselves and secondly to the parents. In addition to the work in the shop they strongly recommend that their apprentices attend the Newark Evening Technical School and a large proportion of the boys are members of that school.

In describing the system in use Mr. Eberhardt said in part:

"At present we have about 65 apprentices, all bound and indentured according to the apprenticeship laws of New Jersey, and have none who are not bound in this manner.

"We have practically two forms of apprenticeship, one for young men about seventeen years of age, embracing what we term our regular course and covering a period of four years of 10,800 hours, and another for two years, or 5,400 hours, called our 'one-branch,' and intended for young men 21 years and older. Reckoning a year at 2,700 hours, in the case of our four-year course, we have a first period of 2,000 hours at 8 cents per hour, a second 2,000 hours at 9 cents, a third 2,000 hours at 10 cents, a fourth 2,000 hours at 11 cents and a fifth 2,800 hours at 12 cents. This makes a total of 10,800 hours.

"The total hours in each period are required to be completed before the next advance in pay is made. We require that the apprentices' parents shall pay us \$1 per week during the first four periods, which amount forms the collateral for a bond which the father or guardian is required to execute. This amount is returned at the expiration of the term, if the said term is completed in a satisfactory manner. However, if for any reason the terms of the papers are violated or the young man runs away, the money paid on account is forfeited. Incidentally, I would say that the amount which we pay the young man, as stated above, is larger than what it was formerly. We made it sufficiently more for the purpose of enabling the parent to pay back the \$1 per week to make good the bond. In this way, we feel, we make it more feasible for a worthy young man, so to say, to pay his own way so far as securing a bondsman is concerned, a collateral bond always having been one of our requirements.

"The regular apprenticeship course includes work at the vise, lathe and planer. In addition, milling machine and gear cutting machine experience, and also other work, is afforded to those boys who show ability to absorb.

"Our experience has taught us that there is so great a variation in capacity that wherever we see a boy who shows ability we do not hesitate to advance him, and when we find a boy who does not possess ability we strongly advise him and his parents to have him take up some other line of work. This we do within the first 4,000 hours of service. It does not always take 4,000 hours to determine this, but there are times when, before taking summary dismissal measures, we try out a boy at more than one branch, or place him with different foremen, so that, in the final disposition of the case, neither the parent nor the boy can say that he was not given a fair trial. For all these efforts expended on the boy up to this time, should he prove deficient and be dismissed, we require that whatever money has been paid on account of the bond be forfeited. This is, in a measure, partly to compensate us for the time spent, work spoiled, etc., in giving the boy a chance to demonstrate, in our opinion or judgment, whether or not he is suited for the trade. The necessity for this measure does not occur often, but we feel that it is absolutely necessary to have some such method of procedure.

"Our second form of apprenticeship, called our one-branch, is for young men who, having attained their majority, realize the necessity for learning some trade and regret not having been given the opportunity in earlier years. This apprenticeship, as stated, is for two years, or 5,400 hours, divided into periods of 2,700 hours each, the first at 12 cents per hour and the second at 14 cents per hour. We require the young men themselves to pay us \$1 per week, the same as before explained. This is paid back at the expiration of the term when completed in a satisfactory manner. This latter amount is also subject to the same penalties as previously mentioned.

"All of our apprentices during their apprenticeship are furnished with the necessary tools required in the several branches and we pass free title to them upon the apprentice completing his term."

### THE SWINDON FIRE TUBE SUPERHEATER.

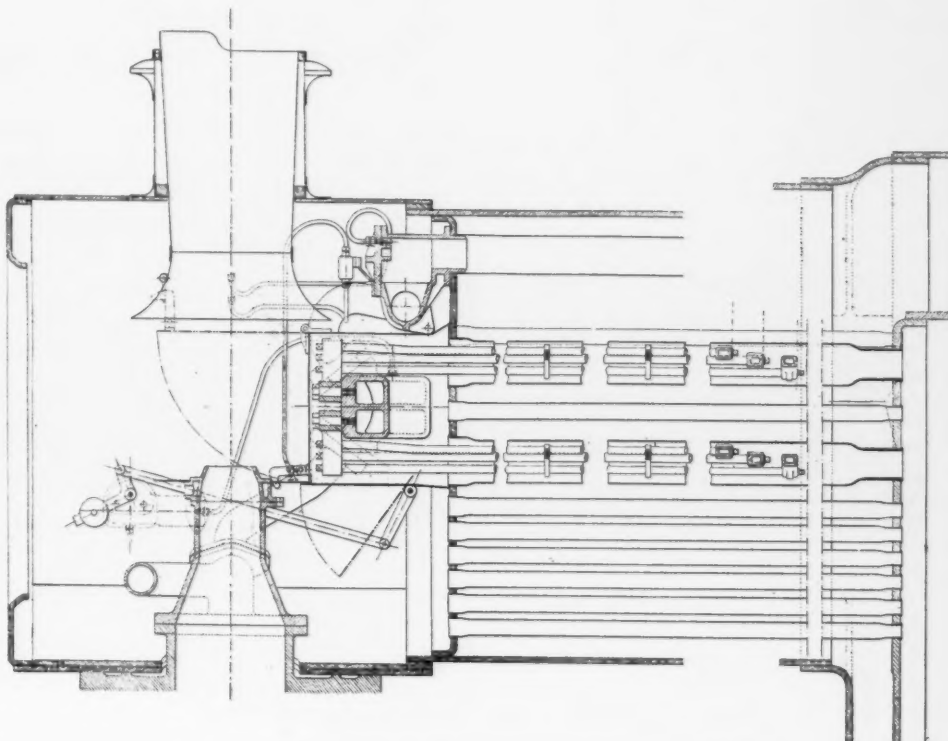
There has been applied to a number of the Great Western (England) locomotives a new type of superheater which is the joint invention of Messrs. G. J. Churchward, locomotive superintendent; G. H. Burroughs, chief draftsman, and C. C. Champeney, draftsman. This superheater has proven to be very satisfactory in operation, and an inspection of the illustrations shown herewith indicates its simplicity of construction.

Reference to the illustrations will show that there are three loops of one inch tubing in each superheater element. Four of these tubes being entirely straight and the two upper ones slightly bent. These six tubes are expanded into U-shaped headers, which in turn are bolted to the large main header which stretches across the smoke box. This connection is made by the use of a single stud, so that by the removal of one nut a complete element can be quickly withdrawn and if necessary a blank flange can be inserted in its place with little or no delay and while the engine is under steam. The tubes forming the elements are maintained in their relative positions by three supports throughout their length.

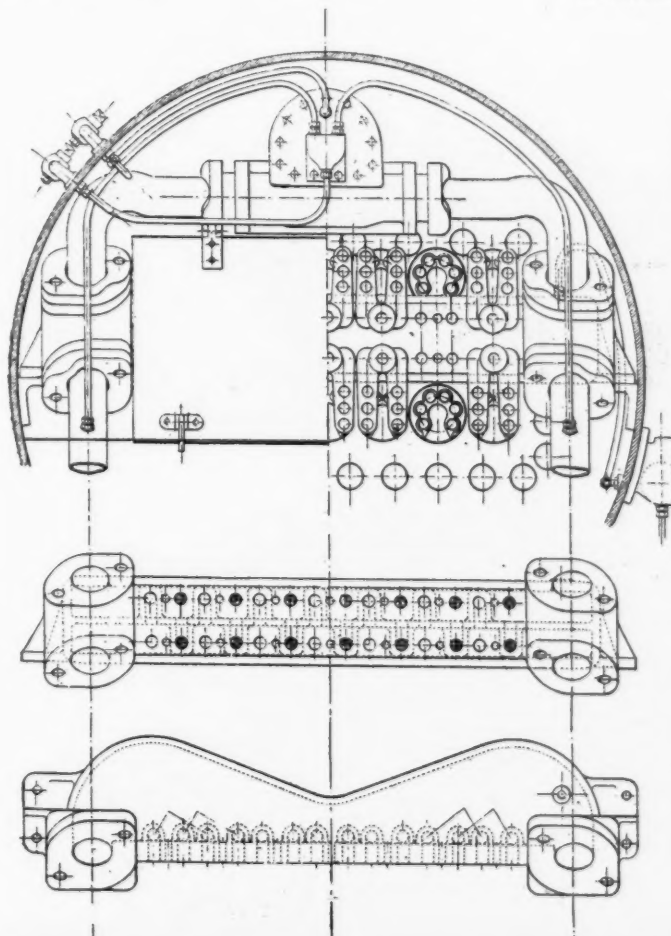
The two rows of fire tubes containing the elements are 5 in. outside diameter and are reduced to  $3\frac{7}{8}$  in. outside diameter at the fire

box end, where they are screwed into the tube sheet. At the smoke box end they are beaded over.

A box encloses the header and the ends of the superheater elements in the front end and in the bottom of this an automatic damper operated by a small steam cylinder is provided. The front face of the box is hinged so that it can be lifted up for access to the header.



SECTIONAL ELEVATION OF SWINDON SUPERHEATER IN BOILER.



SWINDON SUPERHEATER HEADER SHOWING ARRANGEMENT OF ELEMENTS.

**INTELLIGENT WORKMEN NEEDED.**—The mechanical development of this or any other country depends in most part upon the intellect of the workers and the mechanical industries should avail themselves as much as possible of the educated boy, their education being paid for by the mechanical manufacturers as much as by any other citizen of the country. If we could increase the number of intelligent mechanics, we would produce more and better work and our machines would produce better and a larger quantity of work, and they would last longer in our customer's shops if they had intelligent help to handle them.—*B. M. W. Hanson before the Hartford Manufacturers' Association.*

**LOSS OF WEIGHT OF STEEL CARS.**—Out of 1,690 steel hopper cars weighed during the month of April the average decrease in cars which had been weighed within one year, was 702 lbs.; on 478 cars weighed within two years, 1,052 lbs.; on 132 cars weighed within three years, 1,220 lbs.; 92 cars, four years, 1,242 lbs.; 75 cars, five years and over, 1,459 lbs. In May, 671 lbs. on one-year cars; 1,004 lbs. on two-year cars; 1,224 lbs. on three-year cars; 1,571 lbs. on four year cars; 1,705 lbs. on five-year and over. Steel gondolas had not decreased quite so much; 204 cars weighed within one year, 523 lbs.; 152 within two years, 592 lbs.; three years, 878 lbs.; four years, 830 lbs.; five years, 959 lbs.—*J. R. Kearney before the Association of Transportation and Car Accounting Officers.*

**BALTIMORE & OHIO SHOPS.**—The Mt. Clare shops at Baltimore will be improved and enlarged. A new building is to be erected adjoining the present plant, and the foundry and erecting shops will be improved and new machinery installed.

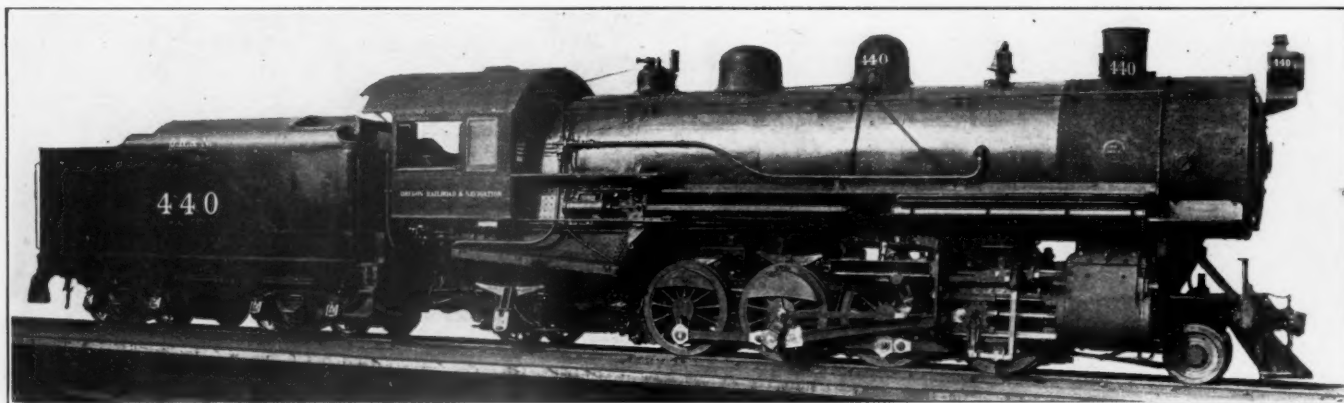
## Powerful Lignite Burner of the Mikado Type.

OREGON RAILROAD AND NAVIGATION CO.

In the Northwest the many extensive deposits of lignite form an unusually cheap grade of fuel and the railroads traversing that country have used it for locomotives in freight service to some extent and are endeavoring to design a satisfactory arrangement whereby it can be used in passenger service. This

the accompanying illustration, which has just been delivered by the Baldwin Locomotive Works to the Oregon Railroad and Navigation Co.

This company as one of the Associated Lines adheres closely to the standards used by the other Harriman lines, but in this

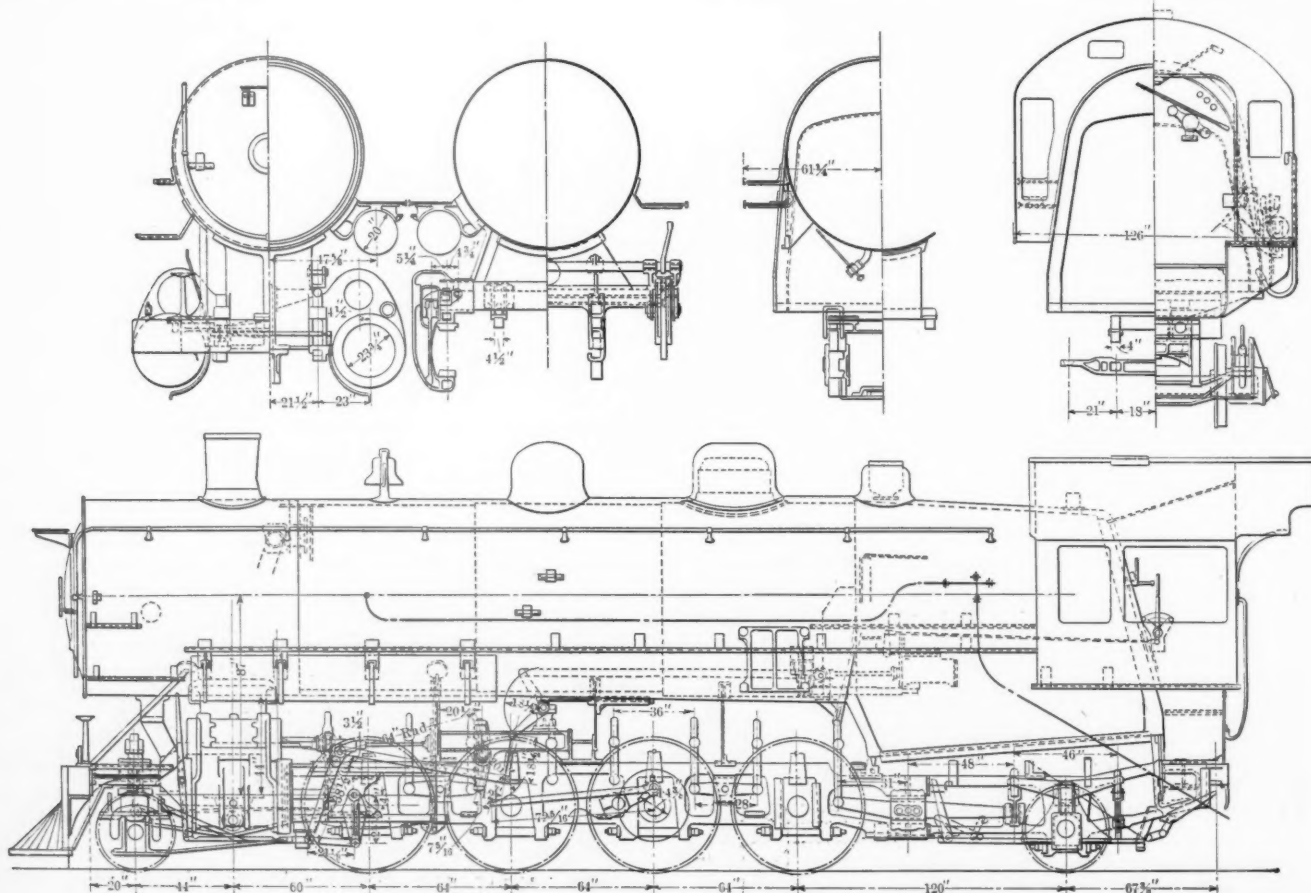


LIGNITE BURNING LOCOMOTIVE FOR THE OREGON RAILROAD AND NAVIGATION COMPANY.

fuel has probably been more extensively used on the Chicago, Burlington & Quincy Railway than on any other and on page 161 of the May, 1908, issue of this journal an illustrated article appeared discussing the development of a satisfactory design of locomotive to burn this fuel on that railroad. Other companies have from time to time purchased locomotives designed to burn lignite and the last of these is the engine shown in

locomotive several changes have been incorporated, the most noticeable being the use of a radial stay boiler in place of the crown bar type. Walschaert valve gear is also used in place of the Stephenson, the design being such that although the combination lever is outside of the guides and the piston valve is inside of the cylinders, no rocker arm is employed.

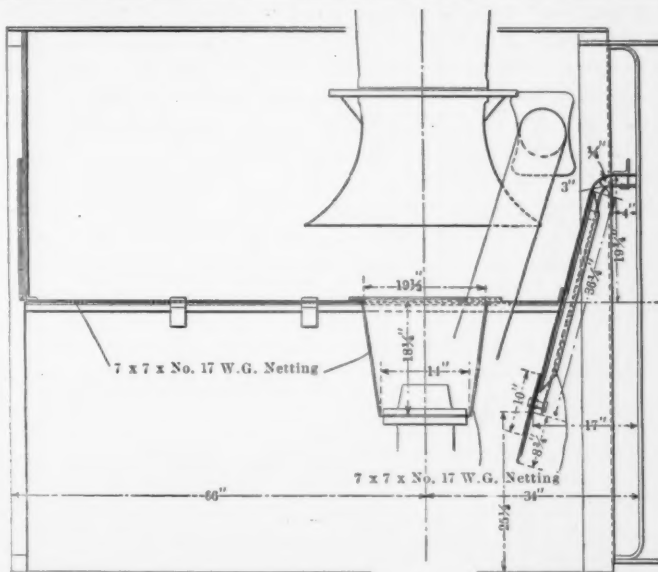
In point of total weight this engine is the largest of any of



ELEVATION AND SECTION OF LOCOMOTIVE DESIGNED TO BURN LIGNITE.

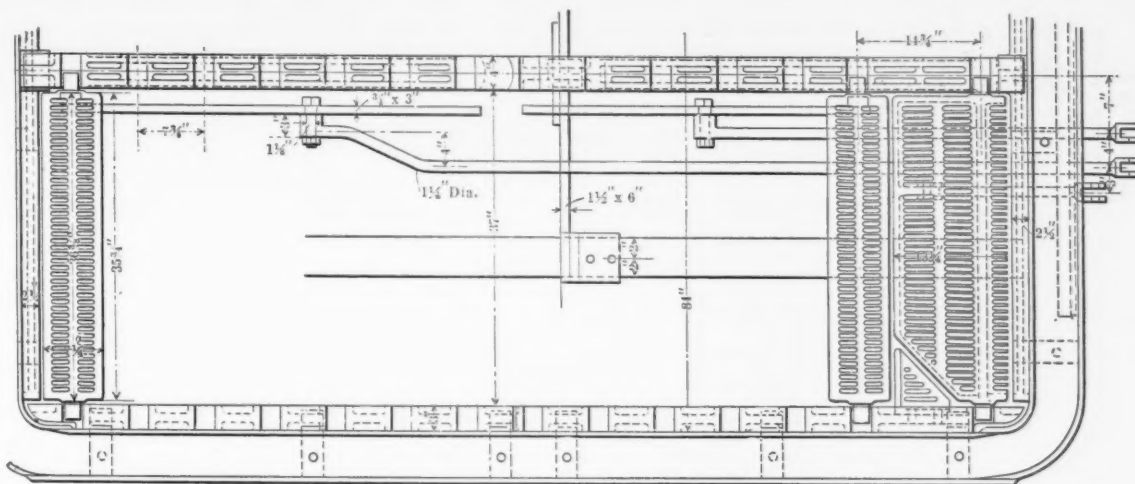
this type on our records, although it is exceeded in weight on drivers by the Virginian engine\* and the Northern Pacific locomotive† and in theoretical tractive effort it is exceeded by both of these as well as by the locomotives built at the Milwaukee shops of the Chicago, Milwaukee & St. Paul R. R.‡ The ratio of weight on drivers to total weight in this case is 77½ per cent., while on the Northern Pacific locomotive it is 78½ per cent.; on the Virginian it is 82 per cent., and on the Milwaukee 77 per cent.

In point of heating surface, however, this design is far in the lead of the other three, having 5,559 sq. ft., as compared to 4,466 on the Virginian; 3,614 on the Milwaukee, and 3,437 on the Northern Pacific. The latter two engines have a large combustion chamber, which accounts to some extent for the small total heating surface. In fact, a study of the design of this locomotive shows that it would probably be over boilered if a good grade of soft coal was to be used. Assuming a steam consumption of 30 lbs. of dry steam per dynamometer horsepower hour, the full tractive effort of this locomotive, at 10 miles per hour, will be obtained with an evaporation of about 6½ lbs. of steam per sq. ft. of heating surface. At this speed the piston speed in feet per minute is 294.8. At a piston speed of 250 ft. per minute, equivalent to 8½ miles per hour, the evaporation per square foot of heating surface, under the same conditions, would be a little over 5½ lbs. of dry steam.



FRONT END ARRANGEMENT FOR BURNING LIGNITE.

that the grate bars are numerous, being connected in four sections for shaking, two on either side of the center line. Two



GRATES DESIGNED FOR BURNING LIGNITE.

One of the illustrations shows the grate designed for burning lignite. It will be noticed that the air openings are narrow and

\* See AMERICAN ENGINEER, page 325, 1909.

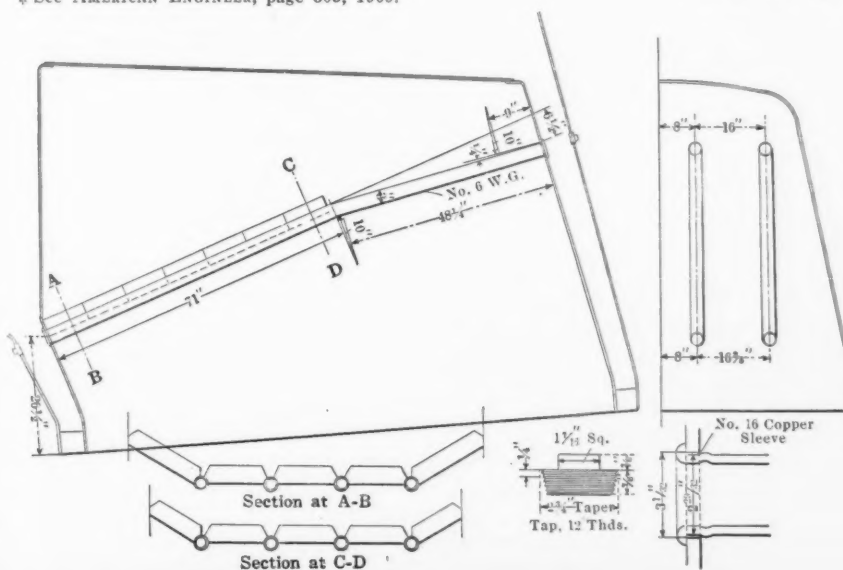
† See AMERICAN ENGINEER, page 392, 1906.

‡ See AMERICAN ENGINEER, page 305, 1909.

large dump grates are provided at the back of the fire box. Another illustration shows the arrangement of the brick arch supported on four 3 in. air tubes. This arch is carried well back and up to reduce the direct pull on the fire as much as possible. In the front end a large area is provided and the diaphragm plate is backed up with a netting for breaking up the sparks as they emerge from the tubes. A low nozzle is used with a bell mouthed interior extension on the stack. The grates and front end arrangement are very similar to those used on the Chicago, Burlington & Quincy illustrated in the article referred to.

As mentioned above, the boiler is of the radial stay design and it has 400 flexible stay bolts distributed on the sides, back and throat sheet. The fire door opening is formed by flanging both sheets outward and riveting them together, a form of construction which has been received with much favor on a number of roads.

In the valve gear design there is nothing unusual except the method of connecting the piston rod to the combination lever. The center of the valve chests are placed 4½ in. inside of the cylinder centers and the com-



ARRANGEMENT OF ARCH TUBES AND BRICK IN THE FIREBOX.



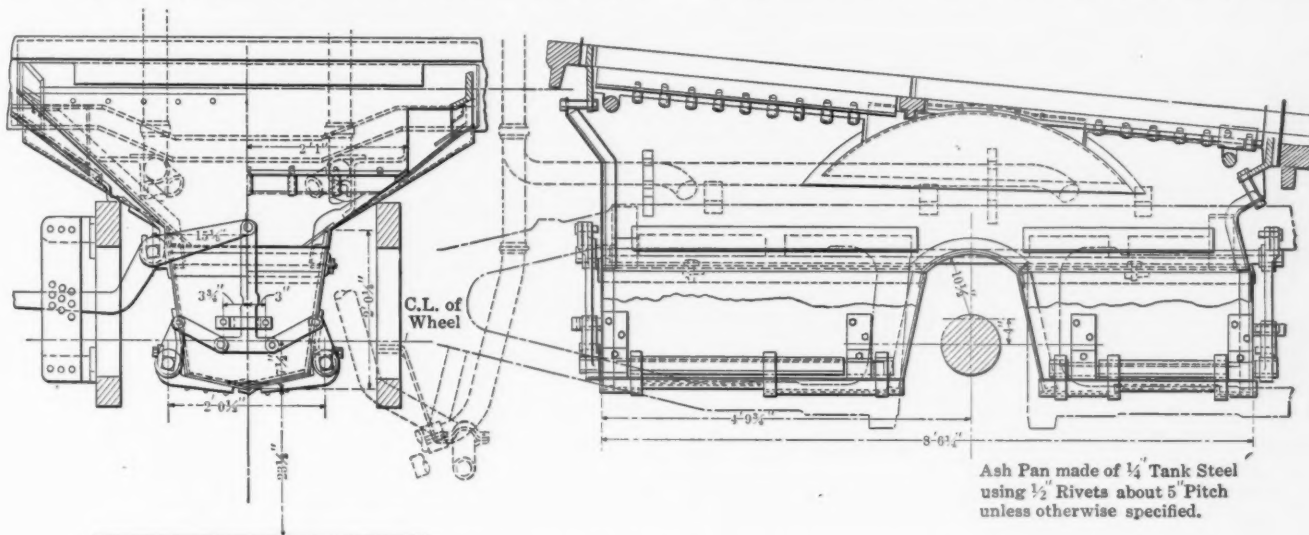
cutting tool by making it of proper shape. The time in finishing a valve stem with this tool is cut in half, and the finish on the stem is entirely satisfactory.

The rollers are  $1\frac{3}{4}$  in. diameter,  $\frac{1}{2}$  in. face and revolve on  $\frac{1}{2}$  in. axles; hinge pins, set screw "B" and stud "A" are  $\frac{1}{2}$  in. diameter and set screw "C"  $\frac{1}{4}$  in. The tool shank is  $1 \times 1\frac{5}{8}$  in. and the cutting tool is  $\frac{1}{2}$  in. square high speed steel; other details proportionate.

### SELF-CLEARING ASH PAN.

PENNSYLVANIA RAILROAD.

In order to comply with the requirements of the Federal law in regard to locomotive ash pans, the Pennsylvania Railroad Company considered quite a number of different designs. After experimenting with several of the most feasible, the design shown in the accompanying illustration was adopted for use on the Pennsylvania System and previous to January 1, 1910, when the law became effective, all of the locomotives owned or operated by the Pennsylvania Railroad Company were equipped



SELF-CLEARING ASH PAN USED ON THE PENNSYLVANIA RAILROAD.

with ash pans meeting the requirements of the law, a large majority of them being fitted with this style of pan.

As far as the pan proper is concerned there is nothing particularly novel about it. It has a large capacity and is very substantially built, flanged pieces replacing straight sheets and angle irons to a large extent. A liberal air opening is provided around the top.

It is in the arrangement of the doors that the principal point of interest lies. The whole bottom of the pan is formed by double doors hinged at the sides and overlapping each other in the center, so that any slight variation or warping will not leave an opening between them when they close. Near the bottom of the pan itself, on each side, are supported in suitable brackets long shafts which are square except where they pass through the supporting brackets. To the door plates are riveted heavy hinged pieces that have square holes through which the shafts pass. On the ends of the square shafts are arms which connect through links to the extensions of inverted T pieces, as is shown in the illustration. On the vertical arm an off-set is made, which, when it comes in contact with the guide, affects the relative position of the two doors, so that there will be no interference between them when being closed or opened.

On one side of the pan and above the hinged shafts is a bearing shaft from which extended arms engage the upper end of the T piece, just mentioned. A suitable lever and lock for this shaft completes the operating details.

Some of the advantages which service operation of this pan

has shown are as follows: The use of a toggle for closing the doors insures a tight fit without any straining or bending of the operating levers. In case either door is stuck the entire force is applied automatically to this door. There is no danger of the doors fouling each other during the process of closing and opening and it is also found that no special instructions are needed covering the method of operating the pan.

After nearly two years operation this type of pan has been found to be entirely satisfactory and is being applied to new locomotives now on order. The operating rigging is patented.

### TRAIN RESISTANCE FORMULA.

In a communication to the *Engineer* (London), Lawford H. Fry, in discussing the paper on "Train Resistance," recently presented by Prof. Schmidt before the Master Mechanics' Association,\* presents the following formula:

$$r = 1.5 + \frac{106 + 2V}{W + 1} + .001V^2$$

$r$  = resistance of car in lbs. per ton (2,000 lbs.).  
 $W$  = weight of car in tons (2,000 lbs.).  
 $V$  = train speed in miles per hour.

which he has derived from Professor Schmidt's data, and states

that it expresses the results of the experiments with the same degree of accuracy as the formula given by Professor Schmidt and has the advantage of expressing the effect of both weight and speed in the same formula.

### A FEW DON'TS FOR ADVERTISERS.

Don't tell all in your advertisements—leave something for the catalogue.

Don't use small type; make reading easy.

Don't be too technical in expression; use terms easily comprehended by the average reader.

Don't make invidious comparisons.

Don't use cuts of unsuitable shapes and sizes because you happen to have them, thereby sacrificing balance and fitness of the advertisement.

Don't expect the compositor to arrange your copy forcibly; you must specify type line by line and furnish skeleton layout.

Don't permit advertisements to run without your final approval.

Don't sacrifice dignity to misapply humor in copy.

Don't crowd type matter; be generous in allowance of white space.—J. C. McQuiston, manager of the Westinghouse Bureau of Publicity in the *Trade Journal Advertiser*.

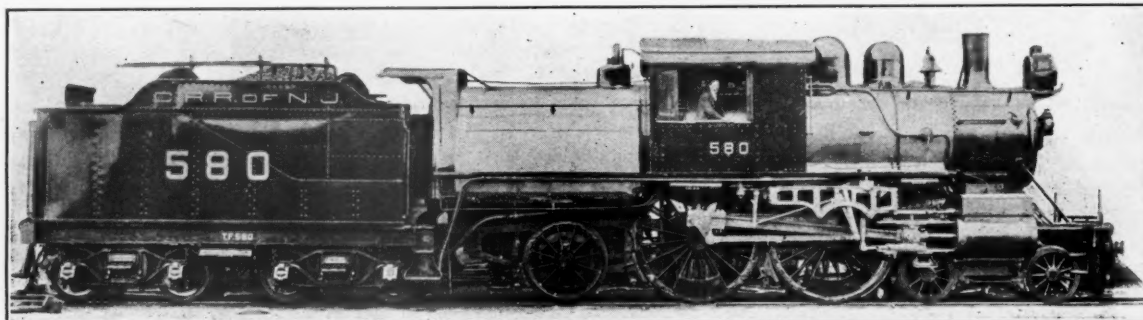
\* See AMERICAN ENGINEER, July, 1910, page 292.

## A NEW RADIAL VALVE GEAR.

A valve gear which evidently has features of advantage over the present design in connection with maintenance is being applied to a number of locomotives throughout the country by its designers and manufacturers, the Hobart-Allfree Company of Chicago.

This gear combines with some original features the basic principles of both the Marshall and Walschaert design. The combination, however, has been worked out with such nicety

for use with the special cylinders and valves manufactured by this company, where a second valve and rod is required. Eliminating that feature, however, the gear is suitable for use with the ordinary piston or slide valve. The motion from the return crank is carried forward through the eccentric rod to a vertical transmission bar that is hung from one arm of the rocker. This transmission bar is also connected to the radius bar from a block which slides on the quadrant above. The position of the radius block on the quadrant is controlled directly from the reverse lever in the cab. When this block is in the center

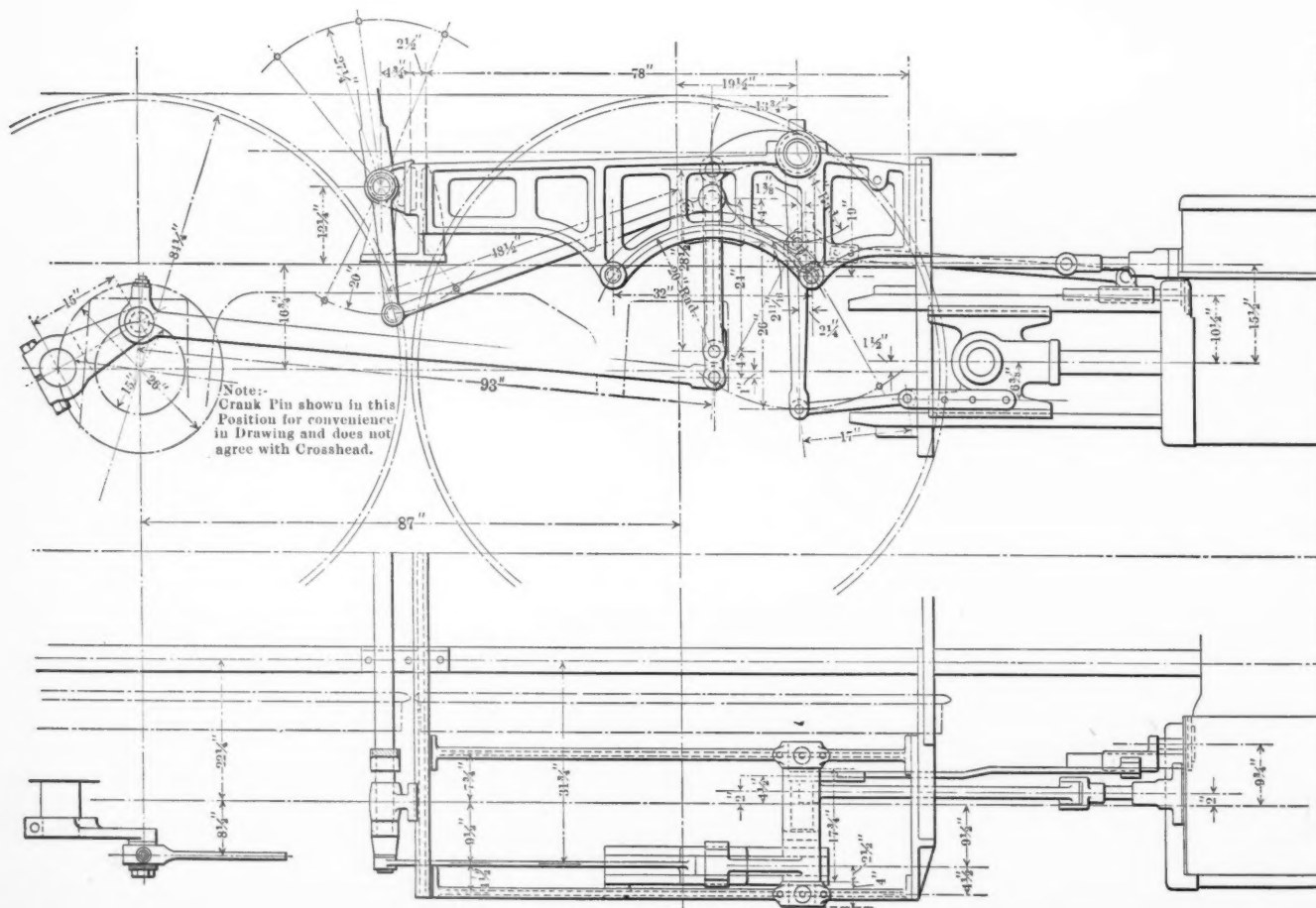


LOCOMOTIVE EQUIPPED WITH THE HOBART-ALLFREE VALVE GEAR.

that the result has been to eliminate the inaccuracies of both arrangements. Furthermore, it is so constructed that no motion is transmitted through a sliding connection. The reversing and adjustment of point of cut-off is effected by the movement of the block over a stationary arc instead of the bell crank usually employed with the Marshall gear, this being but one instance of how the usual arrangement is simplified with an improvement in mechanical design.

Reference to the illustration will show the gear as designed

directly behind the transmission bar the motion of the rocker is practically nil. When, however, it is swung to one side the arc described by the lower end of the radius bar is inclined and the transmission bar has a vertical motion, depending upon the angularity with the horizontal of the path of the lower end of the radius bar. This arrangement being the same as is customarily used with the Marshall gear. The other arm of the rocker connects to the top of the combination lever of the regular Walschaert gear, to which the valve rod is connected in



HOBART-ALLFREE RADIAL VALVE GEAR. THIS DESIGN IS FOR USE WITH THE SPECIAL VALVES AND CYLINDER FURNISHED BY SAME COMPANY.

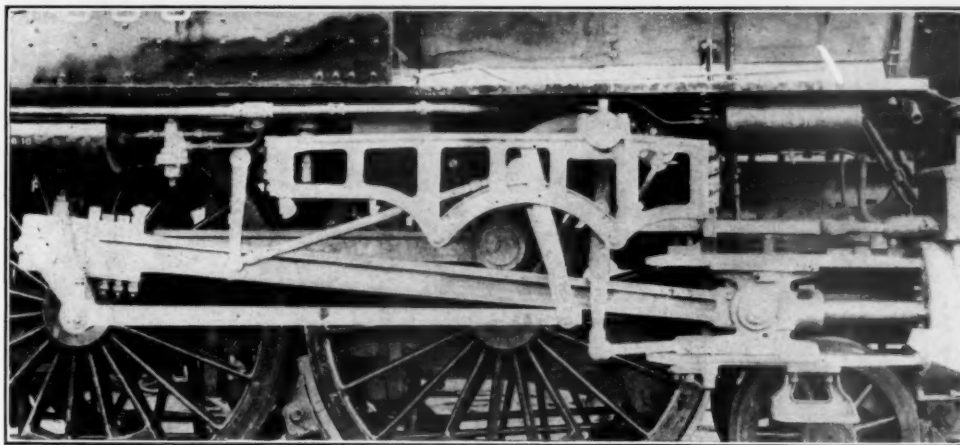
the usual manner. The two arms of the rocker are at the proper angle to equalize the port opening and the ratios of the various parts of the gear are so adjusted as to give an unusually long cut-off in full gear.

This gear complete is carried in a frame secured outside of the driving wheel and supported by cross bars resting on the frame in the same manner as is often used with the Walschaert gear. The gear complete has about the same total weight as a well designed Walschaert gear.

The design of valves and cylinders employed by this company incorporate a separate compression valve, which is introduced through a section of the wall between the cylinder port and the exhaust passage being located beneath and to one side of the main valve. In operation this valve opens simultaneously with the main valve for release, but does not close until some time after the main valve has passed the point of compression. This construction and arrangement was very fully illustrated and described on page 334 of the September, 1906, issue of this journal. At that time the compression valve was operated in-

senger engines, and these methods are now well established on the majority of American railways. By improved methods the operations of cooling down, washing, and filling with hot water may be performed in less than two hours without injury to fire-box and tubes, and this alone has contributed in a large measure to the success of pooling. The reduction in boiler pressure from 225 lb. to 160 and 180 lb. has also reduced the number of boiler failures and permitted the more continuous use of locomotives which results from the pooling system.

The amount of work which the engineers and firemen do at the engine houses is now so small that it is almost confined to lubrication of machinery and inspection of tools and supplies on engines, and no dependence is placed on them for repair work. The engineer is required to report any defects or needed repairs which he observes while running the locomotive or by casual inspection on the outside. The machinery underneath is inspected by men regularly employed for that purpose, and inspection pits in the tracks approaching the engine house are now regarded as an essential of a modern locomotive terminal. With



GENERAL VIEW OF THE HOBART-ALLFREE VALVE GEAR.

ternally by a connection to the main valve and experience with that arrangement has shown it advisable to operate it through an outside connection and the arrangement now used is to operate it by a connection to the combination lever above that of the main valve rod. This point is so chosen as to give the compression valve the same movement that it previously had, *i. e.*, such that it does not affect the steam distribution at any point, except that of compression, which it very materially delays, allowing a free exhaust almost to the end of the stroke and thus permitting a greatly reduced clearance area in the cylinders. In the illustration this connection with the combination lever took the form of an eccentric and strap. That construction, however, is not usually followed.

The service with locomotives fitted with this gear combined with the special valves and cylinders mentioned, is reported as having been most satisfactory, both as to steam consumption and quickness and power in starting.

#### POOLING LOCOMOTIVES.\*

Improved engine house facilities, more system and better organization are favorable to the pooling of locomotives, and this practice has become more general for freight engines in the United States. As recently as in 1905 the reports on pooling presented at the International Railway Congress indicated that pooling was not used on the majority of railways in the United States under normal conditions of traffic. The large increase in traffic in proportion to the number of locomotives in 1906 and subsequent years has compelled most of the roads to resort to the pooling of freight engines and the double-crewing of pas-

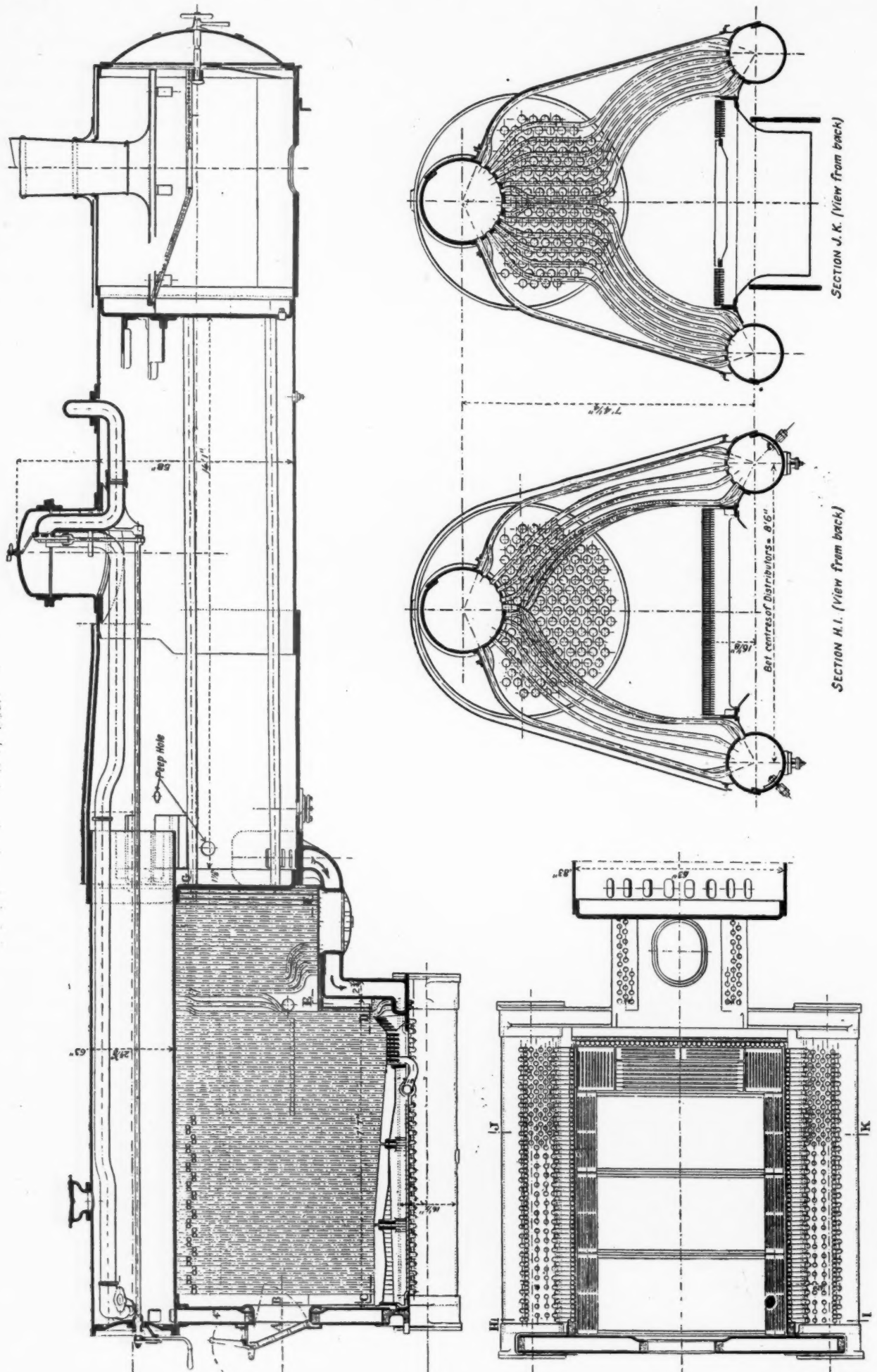
senger engines, and these methods are now well established on the majority of American railways. By improved methods the operations of cooling down, washing, and filling with hot water may be performed in less than two hours without injury to fire-box and tubes, and this alone has contributed in a large measure to the success of pooling. The reduction in boiler pressure from 225 lb. to 160 and 180 lb. has also reduced the number of boiler failures and permitted the more continuous use of locomotives which results from the pooling system.

On some railways where shop facilities are limited, locomotives are required to make a large mileage before they go in for general repairs. The principal items which send engines frequently to the shop are worn tires, defective tubes, and, perhaps, worn driving boxes. At some engine houses all these repairs are made, the worn tires being replaced by new ones or by others which have been turned at the shop. In this way such machinery as rods, crossheads, guides and link motion, is kept in service, so that passenger locomotives make as high as 127,000 miles, and freight locomotives, 100,000 miles between general repairs, one passenger locomotive making 256,000 miles between shop-pings. Passenger locomotives average 120,000 miles and freight locomotives, 95,000 miles.

On the Chicago, Burlington & Quincy for the last six months of 1909, pooled freight engines made on one division as high as 4,167 miles per month and 110 engines on three divisions averaged 3,777 miles per month. On other roads passenger engines double-crewed make an average of 6,500 to 7,500 miles per month, one road reporting for engines in express service 418 miles per day and 12,780 miles per month.

ABILITY NOT AGE THE GAUGE.—A man's age is only a factor when it improves his ability, and if a young man has the same ability as an old man, that is, he has reached a high point of efficiency at a younger age than other men, it is his good fortune and he should not be deprived of this advantage because of his age.—B. M. W. Hanson before the Hartford Manufacturers' Association.

\* From a paper by William Forsyth before the joint meeting of the A. S. M. E and I. M. E. at Birmingham, England.



## LOCOMOTIVE WITH WATER TUBE FIRE BOX.

NORTHERN RAILWAY OF FRANCE.

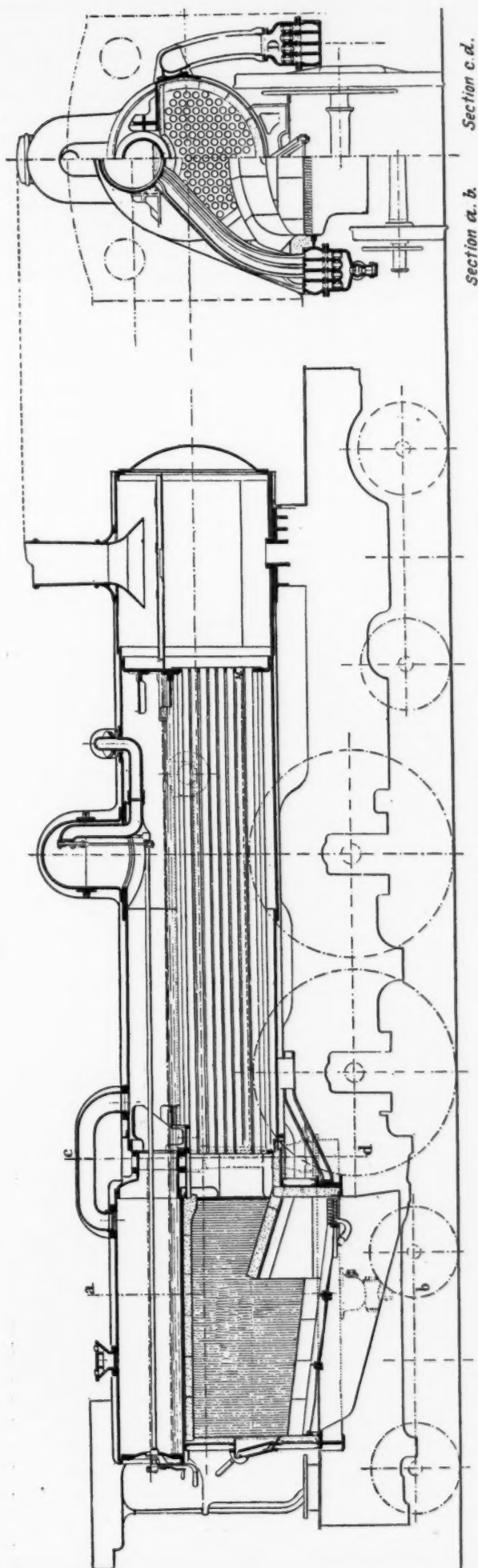


FIG. 1.—TYPE OF WATERTUBE FIREBOX FIRST USED ON THE NORTHERN RAILWAY OF FRANCE.

There is on exhibition in the French section of the Brussels Exposition a passenger locomotive with a very interesting application of water tube fire box. This locomotive is the culmination of about three years' experience with a water tube fire box on the Northern Railway of France. The engine built in 1907 is shown in Fig. 1 and was operated 67,000 kilometers (42,000 miles) before being replaced with the design shown in Fig. 2.

In the latter example, which was designed by the director of the Creusote Steel Works under the general direction of M. du Bousquet, the principal causes of failure in the first arrangement have been eliminated. These troubles were due largely to the use of the brick walls and bridge at the front end of the fire box, which were rapidly destroyed in spite of every preventive device introduced. All of this brick work has been eliminated in the second model and a combustion chamber has been introduced in its place for the proper protection of the fire box tube sheet, which had suffered from the action of the hot gases to an extent which made it impossible to keep the tubes tight. Reference to the section J-W in the illustration will show that the forward row of tubes forming the side legs of the fire box are bent inwards at a sharp angle and then carried up vertically to the steam drum. These act as a screen for the combustion chamber, break up, and mix the gasses passing through them and incidentally absorb a large amount of heat. In the first model a heavy steel plate was used for the tube sheet, and it was found that its rigidity in connection with the use of ribbed tubes was responsible for much of the leakage. Therefore, in the later design the tube sheet is of copper and the Servé tubes are deprived of their ribs for a length of about 16 in. and are drawn down from  $2\frac{3}{4}$  to  $2\frac{1}{4}$  in. diameter on that length.

In the first design there were no water legs at the front or back of the fire box, but it will be noticed that they have been provided in the later arrangement. In the first design also the lower drums were steel castings in two sections, which were bolted together. These have now been replaced by riveted steel drums into which the tubes are expanded the same as in marine practice.

Another alteration in the design will be seen in connection with the large pipe connection between the boiler shell and the front of the side drums, which was carried at a point above the center of the barrel. In practice it was found that when the fire was kindled a hot water current was rapidly set up through the water tubes, the upper part of the boiler barrel and these large side pipes, whereas the lower part of the boiler barrel unaffected by this circulation remained for a long time at a lower temperature, with a consequent unequal expansion in the barrel that caused trouble. This difficulty has been remedied by taking the water from the bottom of the boiler barrel through the regular water leg, formed in this case by steel castings and connected to the bottom headers of the fire box. The connection of these cast steel passages forms the bottom of the combustion chamber, and the sides are formed by small water tubes closed tight together, and forming a gas tight wall.

The arrangement and shape of the tubes is well shown in the illustration. Those which are exposed to the more direct action of the flames are 5 mm. (.2 inch) thick and the others  $2\frac{1}{2}$  mm. (.1 inch) thick.

Service with this later design has been very satisfactory during the 33,000 kilometers (22,000 miles) it operated before going to the exhibition. No flue leakage occurred and there are practically no deposit of scale in the water tubes. Tests showed that while the temperature in the fire box sometimes runs up to 2,372 degs. F., the temperature at the entrance to the flues was only about 1,562 degs. F. and the smoke box temperature 672 degs. F.

This water tube fire box boiler has been applied to the standard compound locomotive which as ordinarily used is of the

4-4-2 type. It was found, however, that the weight of the new firebox was such as to require the use of the 4-4-4 type. This engine, with a load of 270 tons behind the tender, is easily able to maintain a speed of 64 to 65 miles per hour on a steady rise of  $\frac{1}{2}$  of 1 per cent.

The general dimensions of this boiler as given in the *Railway Engineer*, to whom we are indebted for the information and illustrations, are as follows:

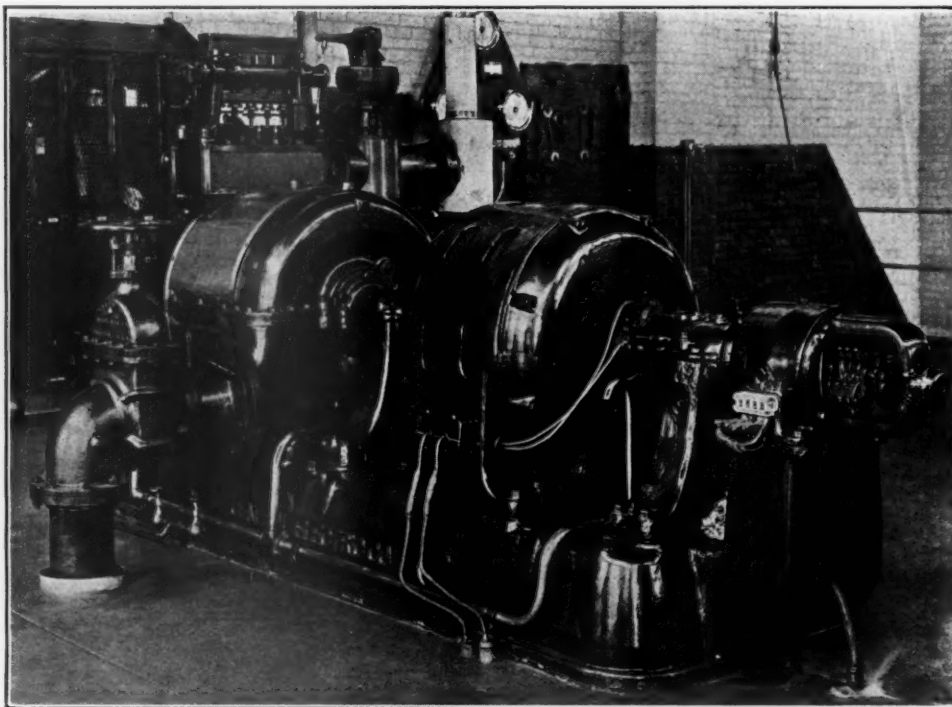
Pressure .....	256 lbs.
Grate area .....	38 sq. ft.
Heating surface, fire box.....	1033 sq. ft.
Heating surface, tubes .....	2375 sq. ft.
Heating surface, total .....	3408 sq. ft.
Water tubes, number and diameter.....	290—1.38 in.
Water tubes, number and diameter.....	168—1.38 in.
Water tubes, combustion chamber, number and diameter.....	44—1.38 in.
Fire tubes, number and diameter.....	136—2.76 in.
Fire tubes, length .....	14 ft.
Cubic capacity of boiler for water.....	217 cu. ft.
Cubic capacity of boiler for steam.....	88 cu. ft.
Total weight of boiler and accessories.....	30 tons
Cylinders, diameter .....	13.4 and 22 in.
Cylinders, stroke .....	25.2 in.
Driving wheel, diameter .....	80 in.
Maximum tractive effort compound.....	22,600 lbs.
Total weight of locomotive in working order.....	170,000 lbs.

### ELECTRIFICATION OF THE CHESAPEAKE & OHIO SHOPS AT HUNTINGTON, W. VA.

The greater flexibility and efficiency of electric transmission in large shops is coming to be more widely recognized and in spite of the comparatively high cost of installation into a shop already

electric drive may be apparent to the shop superintendents, it has always been a difficult matter to obtain authority for making a change of this kind.

The new plant, which was put in service March 1, 1910, is an all turbine station, the only reciprocating machinery besides the boiler feed pumps being two two-stage air compressors furnished by the Ingersoll Rand Co. and the Chicago Pneumatic Tool Co. to supply compressed air at 100 lbs. pressure for the portable drills, hammers and hoists about the various shops. The reliability, safety and high efficiency of modern steam turbines, when operating at a varying load such as that of a machine shop, led to their selection for this purpose. Three Curtis turbines and one motor generator exciter have been installed, this equipment consisting of one two-bearing over-hung non-condensing turbine with a speed of 3,600 r.p.m. connected to a 25 k. w. 125 volt D. C. exciter; one four-bearing three-unit, 100 k. w. set consisting of one non-condensing 3,600 r.p.m. turbine, one three-phase, 60 cycle, 480 volt, 100 k. w. generator and one 4 k. w., 125 volt D. C. exciter; and also one three-bearing four-stage condensing turbine with a speed of 1,800 r.p.m. connected to a 750 k. w., three-phase, 60 cycle generator. The illustration shows the 100 k. w. Curtis turbine direct connected to its generator. All of these turbines are equipped with oil pumps geared directly to the main shaft and the bearings are fitted with oil rings. The large 750 k. w. and 100 k. w. turbines are equipped with a mechanical speed controlling valve gear driven directly from the main shaft. The 750 k. w. turbine is connected to a Westinghouse-LaBlanc jet condensor whose circulating and rotary air pumps are driven by a 75 h. p. induction motor, the injection water being cooled by a natural draft cooling power, which arrangement maintains a vacuum of about 27 in. For



CURTIS TURBINE GENERATOR IN THE POWER HOUSE AT HUNTINGTON, W. VA.

in operation, some railroads have been availing themselves of these advantages in addition to increased output of the shop and the saving in operating expenses and large amount of space which may be effected by this means.

The Chesapeake and Ohio Railroad Company has recently changed its shops, which were formerly operated from four independent stations equipped with old locomotive boilers and reciprocating engines belted to line shafting in the different shops, from line shaft to electric drive. The conditions existing before the change was made are similar to those found in a great number of railroad shops, and while the many advantages of

facilitating the erecting and subsequent handling of this machinery the engine room is provided with a  $7\frac{1}{2}$  ton Harris hand crane extending across the entire room. There is a standard General Electric 8 panel switchboard consisting of two machine panels, two exciter panels, four 3-circuit feeder panels and one-half panel on which a voltage regulator is mounted. In addition to the switchboard, all instruments in connection with it were furnished by the General Electric Co.

The boiler equipment consists of five 275 h. p. Sterling water tube boilers, equipped with shaking grates. No ash handling or coal conveying machinery has been installed, the ashes being

shoveled from the ash pits into small cars and conveyed in this manner to the dump. Coal is delivered in railroad cars on a trestle just outside of the boiler room and dumped into coal bunkers, from where it is carried by gravity through chutes to a point within easy reach of the firemen. The smokestack, 200 feet high, is built of reinforced concrete and is provided with a Bushnell damper regulator. Condensing and boiler feed water is supplied from a small pumping station located outside of the shops, and the feed water is pumped from an open heater to the boilers by two duplex pumps, the piping being so arranged that the condensing water may be pumped directly from the hot well to the cooling tower.

Induction motors totaling about 1,000 horsepower are used throughout the machine shop, boiler shop, roundhouse, planing mill and tin and pipe shops. They range in size from 15 to 100 horsepower each, for driving the different tools in the shops. Most of the machines are belt driven and only the larger tools are equipped with individual motor drive. A sawdust and shaving exhaust system has been installed in the planing mill, driven by a 100 h. p. induction motor. The storage battery charging station for passenger coaches is equipped with a motor generating set and the dismantling shop is spanned by a 120 ton four-hook Harris electric crane equipped with four variable speed induction motors of the slip ring type.

The various buildings about the shop are heated by the exhaust steam from the two air compressors, boiler feed pumps, the 25 k. w. and 100 k. w. turbines, the condensation from the system being pumped into the boiler feed water heater. This arrangement reduces the back pressure in the exhaust header to from four to eight lbs. per square inch.

The saving in coal alone effected by the changes made in this plant is about 50 per cent., caused in part by the great economy in steam consumption of the turbines and chiefly by the elimination of the large amount of shafting and belting, which usually consumes about 50 to 60 per cent. of the total power for a shop of this kind. A saving of 66⅔ per cent. in the labor required to operate the plant has also been effected, due partly to the improved method of handling fuel and ash, and partly to the comparatively smaller number of men required to operate a turbine station. In addition to this saving in fuel and labor the capacity of the entire shop has been increased about 50 per cent. During the month of April 34 locomotives were repaired, while 20 locomotives was considered an exceptionally good month's work previous to the change. The electric drive in this case not only increased the output, but also the flexibility of the entire shop was increased, so that at the present time any section of the shop can be worked independently of the other sections and sufficient power is available at all times so that workmen can work to advantage at night as well as during the regular working hours.

The engineering of the entire plant was done by Westinghouse, Church, Kerr & Co., of New York City.

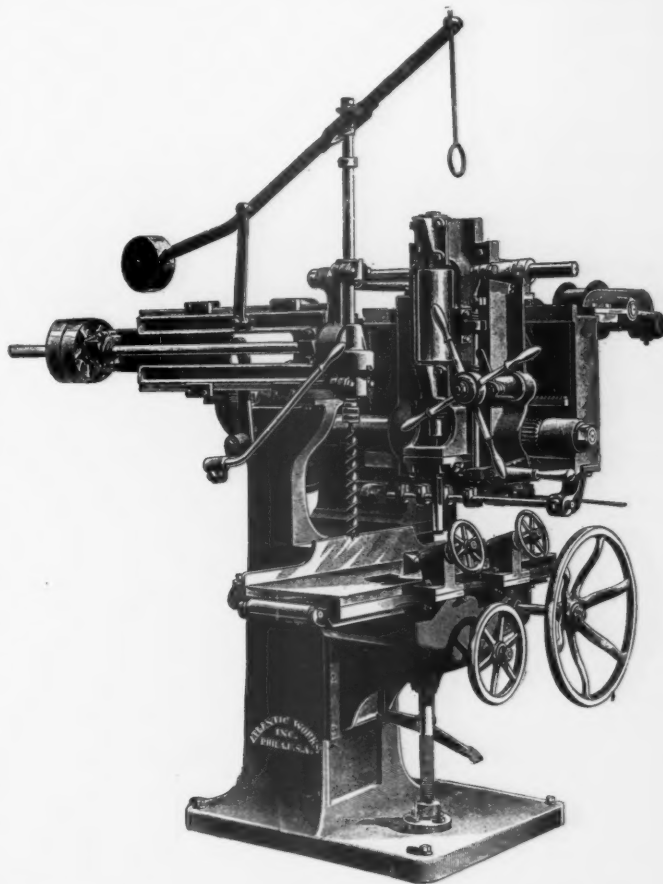
#### VERTICAL HOLLOW CHISEL MORTISING MACHINE

A new mortising machine specially designed for work in car shops is shown in the accompanying illustration. It is of the vertical hollow chisel type and is provided with a boring attachment. The adjustment is such that it can make mortises very rapidly from 1 to 1½ in. in width of any length and up to 6 in. in depth if needed. The stroke of the chisel ram is regulated by a system of stops and can be increased or decreased at will, the maximum stroke being 6½ in. At this depth the automatic attachment provides for 35 strokes per minute, which is increased as the stroke is shortened. It has a very quick return. A horizontal adjustment of 3 ft. and a vertical adjustment of 14 in. is provided on the table shown and a table with a horizontal adjustment of 10 ft. with the same vertical adjustment can be fitted if desired.

The boring spindle has a vertical movement of 12 in. and a

transverse movement of the same amount, both being controlled by hand levers, as is clearly shown in the illustration. It will carry augers up to 2 in. in diameter and provides a very powerful drive.

This machine, which weighs 4,000 lbs. when fitted with a 4-ft.



COMBINED HOLLOW CHISEL MORTISING AND BORING MACHINE.

table, is designated as the No. 10 by the Atlantic Works, Inc., 28th St. and Gray's Ferry Road, Philadelphia, who are the manufacturers. Long experience in designing machines of this character fits this company exceptionally well for turning out a product that is perfectly suited for the work to be performed.

THE VALUE OF R. R. CLUBS.—The very fact that its rules do not bar or favor certain departments of the railroad, is positive proof value of the of the clubs. It insures papers from each department, and although papers are more thoroughly discussed by each respective department that the papers pertain to, yet the different departments are so closely allied that it is not an uncommon occurrence for several departments to take up the same discussion. This shows a broadening out of the railroad employees. Time was when each employe stayed in his own department, worked for his own department, and cared very little as to what was going on outside of his own circle, for which he was designated and paid. Never in the history of railroading has there been such an interest displayed by employees in one department, as to what is transpiring in another. Not in a jealous nature, but one of interest for the employer and at the same time, of learning, progressiveness and push. The sociability, mixed with business, now-a-days among railroad employes, has fought many a battle, and taking all things into consideration, there are to-day practically no departments on a railroad, as it were, because of this mixing, good fellowship and get together idea. I can well remember when jealousy among railroad employes was the biggest enemy that the railroad and employes had to contend with.—J. W. Kreitter, Supt. Duluth, Missabe & Northern Ry., before Northern Ry. Club.

# EQUIPMENT AND EXTENT OF ELECTRIFIED STEAM RAILROADS AND ELECTRIC TRUNK LINES.\*

The locomotives on which data are given in the accompanying tables were built for heavy railway service. They are for passenger service and for combined passenger and freight, and include locomotives for direct current, three-phase current, and single-phase alternating current, and others adapted for operation on either single-phase alternating current or direct current.

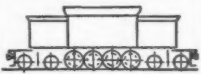



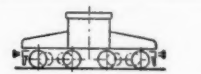
The following tables give data of the important railways on which electricity is used in heavy service. Only such figures are included as were conveniently available, and such omissions or inaccuracies as may occur do not detract materially from the forceful presentation of the extent and character of the use which is now being made of electricity in railway service. The horsepower ratings of the various motor cars and locomotives are in general the nominal ratings for a short period, usually




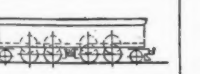
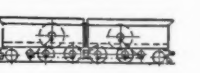
\* From the appendices of the paper on "Electrification of Railroads," by George Westinghouse, president A. S. M. E., presented at the joint meeting with the Inst. Mech. Engrs., July, 1910.

one hour, but as these ratings have been adapted in some cases to the particular service in which the motors are to operate, they cannot be taken as a basis for an accurate comparison between the capacities of different equipments.

## Single-Phase Electrification on Steam Railways and in Trunk Line Service.

Road.	Miles		Line voltage.	Motor cars		Locomotives	
	Of line.	Single track.		No.	H.p.	No.	H.p.
N. Y., N. H. & H.:							
Main line .....	21	100	11,000	4	600	41	1,400
New Canaan Branch ..	8	8	11,000	2	500	2	1,600
Grand Trunk .....	3.5	12	3,300	..	..	6	900
Erie: Rochester Division.	34	34	11,000	6	400	..	..
Colorado & Southern:							
Denver & Interurban ..	46	46	11,000	8	500	..	..
Baltimore & Annapolis:							
Short line .....	25	30	6,600	12	400	..	..
Swedish State Rys.....	7	7	20,000 { 3,300 }	2	240	1	300
Midland Ry. of England..	8.5	17	6,600	2	360	..	..
Prussian State .....	16.5	31	6,600	20 { 42 { 54 {	250 { 400 { 345 {	1	1,500
Lon., Brighton & S. Coast.	8.6	17.2	6,000	16	460	..	..
Rotterdam-Haag-Scheveningen .....	20.5	46.5	10,000	19	360	..	..
Spokane & Inland.....	129	129	6,600	28	400	5	720
Midi Ry. of France.....	75	..	12,000	30	500	2	1,600

					
Built for.....	N. Y. C. & H. R. R.	Detroit River Tunnel	B. & O. R. R.	Great Northern	Paris-Orleans
Electric system.....	D.C.	D.C.	D.C.	3-phase	D.C.
Service.....	Passenger	Frt. & Pass.	Frt. & Pass.	Frt. & Pass.	Passenger
First placed in service.....	July 1906	tests completed	March 1910	July 1909	1899
No. in service or on order May 1910	47	6	2	4	11
No. motors per locomotive.....	4	4	4	4	4
Armature diameter, inches.....	29	25	25	35 1/4	23 1/2
Core length, including vent opening, inches.....	19	11 1/2	11 1/2	16 1/4	12
Weight one motor, pounds.....	18,150	10,560	10,560	15,000	8,855
Weight all motors on locomotive ..	72,600	42,240	42,240	60,000	35,420
Weight all electrical parts.....	91,200	54,000	54,000	109,000	42,500
Weight all mechanical parts.....	138,800	146,000	130,000	121,000	67,500
Weight complete locomotive.....	230,000	200,000	184,000	230,000	110,000
Weight on driving wheels.....	141,000	200,000	184,000	230,000	110,000
Weight complete locomotive for A.C. operation.....					
Max. guar't'd speed, miles per hr.	D.C.	D.C.	D.C.	230,000	D.C.
Feature limiting speed.....	75	30	55	30	45
Max. tractive effort.....	track	armature	armature	armature	armature
Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation..	47,000	67,000	61,000	77,000	37,000
Designed for trailing load, tons.....	none	none	none	none	none
Freight.....		900 { on	850 { on	500 on 2.2% grade	
Passenger.....		600 { 2% grade	500 { 1 1/4% grade		
Balance speed on level with above load.....	435 {	20.5 {	26 {	15	300 {
	63 }	Pass. 22 }	Pass. 30 }		32 }

					
Built for.....	New Haven	Grand Trunk St. Clair Tunnel	Pennsylvania	New Haven	New Haven
Electric system.....	A.C., D.C.	A.C.	D.C.	A.C., D.C.	A.C., D.C.
Service.....	Passenger	Frt. & Pass.	Passenger	Frt. & Pass.	Frt. & Pass.
First placed in service.....	July 1907	February 1908	17,000-mile test	3000-mile test	building
No. in service or on order May 1910	41	6	24	1	1
No. motors per locomotive.....	4	3	2	4	2
Armature diameter, inches.....	39 1/2	30	56	39 1/2	76
Core length, including vent opening, inches.....	18	14 1/4	23	13	13
Weight one motor, pounds.....	16,420	15,660	45,000	19,770	41,600
Weight all motors on locomotive ..	65,680	46,980	90,000	79,080	83,200
Weight all electrical parts.....	110,400	58,400	127,200	130,000	135,000
Weight all mechanical parts.....	94,100	73,600	204,800	130,000	125,000
Weight complete locomotive.....	204,500	132,000	332,000	260,000	260,000
Weight on driving wheels.....	162,000	132,000	207,800	180,000	180,000
Weight complete locomotive for A.C. operation.....					
Max. guar't'd speed, miles per hr.	196,000	132,000	D.C.	241,000	240,000
Feature limiting speed.....	about 86	30	about 80	45	45
Max. tractive effort.....	track	armatures	connecting rod	armatures	armatures
Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation..	19,200	43,800	69,300	40,000	40,000
Designed for trailing load, tons.....	88,700	none	none	18,500	17,500
Freight.....	250	500	550	{ 1500 freight }	{ 1500 freight }
Passenger.....				{ 800 pass. }	{ 800 pass. }
Balance speed on level with above load.....	about 75	about 25	60	{ 35 freight }	{ 35 freight }
				{ 45 pass. }	{ 45 pass. }

*Continuous-Current Electrification on Steam Railways and in Trunk Line Service.*

Road.	Miles		Line voltage.	Motor cars		Locomotives	
	Of line.	Single track.		No.	H.p.	No.	H.p.
New York Central .....	33	132	650	137	400	47	2,200
Pennsylvania .....	20	75	650	180	400	24	4,000
West Shore .....	44	106	650	20	360	..	.....
Long Island .....	42	125	650	137	400	2	1,200
West Jersey & Seashore..	75	150	650	68	400	..	.....
Baltimore & Ohio.....	3.7	7.4	600	..	...	2.5	1,600
Northeastern Railway ...	37	..	600	..	300	2	600
Mersey Tunnel .....	4.8	..	600	24	400	..	.....
Lancashire & Yorkshire..	18	60	600	..	600	..	.....
Great Western .....	5	..	600	..	600	..	.....
Metropolitan Railway ....	..	67	600	56	600	10	800

*Car Equipment of Subway and Elevated Systems in American Cities.*

The Direct-Current Third-Rail System at Approximately 600 Volts Is Used in All Cases.

Road.	Miles of single track.	Motor cars	
		No.	Horse-power.
Boston Elevated .....	19	219	320
Brooklyn Rapid Transit.....	71	558, 101	300, 400
Interborough Rapid Transit (New York)	190	969, 764	250, 400
Hudson & Manhattan (New York).....	12	140	320
Chicago & Oak Park Elevated.....	19.4	65	320
Metropolitan West Side (Chicago).....	51.1	15, 210	400, 320
Northwestern Elevated (Chicago).....	25.5	20, 128	250, 320
Southside Elevated (Chicago).....	36.5	150, 70, 150	180, 150, 110
Philadelphia Rapid Transit.....	11	100	250

*Three-Phase Electrification on Steam Railways and in Trunk Line Service.*

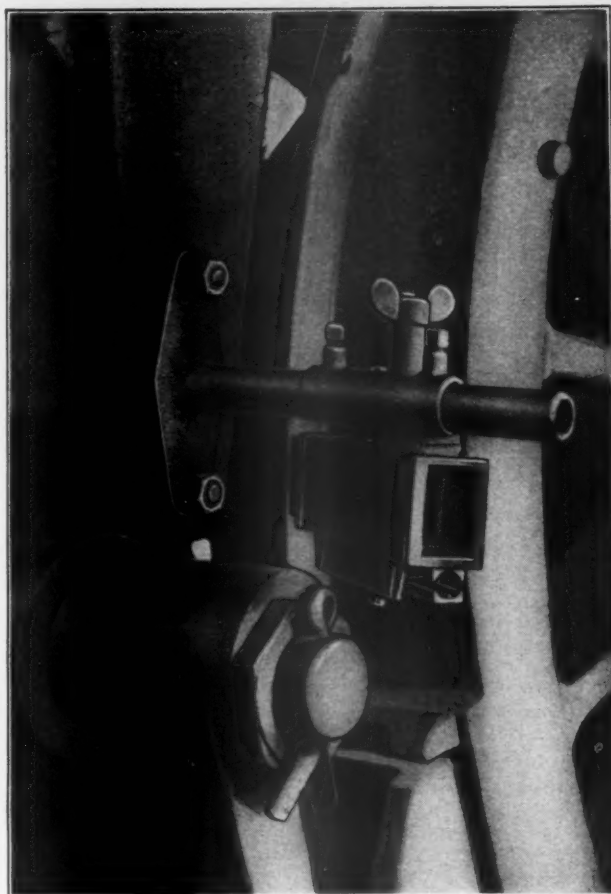
Road.	Miles		Line voltage.	Motor cars		Locomotives	
	Of line.	Single track.		No.	H.p.	No.	H.p.
Gt. Nor. (Cascade tunnel)	4	6	6,600	..	...	4	1,900
Italian State Railways:							
Valtellina Railway .....	66	..	3,000	10	400	2	800
Giovi Railway .....	12.4	37.3	3,000	..	...	20	2,000
Mt. Cenis Tunnel .....	4.4	..	3,000	..	...	10	2,000
Savona Ceva .....	..	..	3,000	..	...	10	2,000
Swiss Federal Railways:							
Simplon Tunnel .....	13.7	14.3	3,000	..	...	2	1,100
Garagal Santa Fe (Spain)	13.1	14.4	5,500	..	...	5	320

**DRIVING WHEEL FLANGE LUBRICATOR.**

On roads having numerous curves the matter of sharp flanges is one of the most important and expensive features of maintenance that have to be contended with. Recently the practice of lubricating the flange of a driving wheel has been introduced with very decided success and it has been found that a locomotive equipped with a flange lubricator will in some cases give twice the mileage before it needs to be taken in for tire turning that was previously possible. While, of course, the expense and delay in turning tires is the most important feature in this connection there is also some gain in the power of the locomotive, there is considerably less wear on the rail heads and the general machinery of the locomotive is not strained as much.

In applying a flange lubricator it is of particular importance that it shall operate and be of such form that there will be no possibility of getting any of the lubricant on the wheel tread or the head of the rail. Therefore, while oil has in certain instances been used with some success, a solid block of lubricant, as a stick of graphite, is much more satisfactory.

In the accompanying illustration is shown a wheel flange lubricator which has proved remarkably successful in practice. Its simplicity and durability are easily recognized from the photograph and it will be seen that it is provided with all necessary adjustments and so designed that it can be easily located to avoid sand pipes, brake hangers, and other parts. It is recommended by the manufacturers of this appliance, the Collins Metallic Packing Co., of Philadelphia, that it be set at an angle of 25 degs. with the axle, and while it can be located on either the front or back of the wheels, they recommend that it be on the front of the leading wheel and on the rear of the back driving wheel, and that it also be set slightly above the center line. There is a compression latch on the bottom of the device which engages the lubricating block. One setting of the block is sufficient for two or three hundred miles' service, and pulling the compression device back one notch can be done in an instant and prepares the lubricator again for an equal service. A new block can also be applied very easily. The manufacturers report



WHEEL FLANGE LUBRICATOR APPLIED TO FRONT DRIVER.

that one lubricating block will make from 2,500 to 3,000 miles on a high speed passenger and 3,500 to 4,000 on a switch engine. The heating of the tire, due to excessive braking, does not affect the efficiency of the lubricator.

**ONE LOCOMOTIVE PULLS 120 LOADED CARS.**

On August 23 Pennsylvania locomotive No. 1221, Class H8b\* left Altoona, east bound, with 120 loaded cars, the gross tonnage of cars and lading being 8,850 tons. The train left the yard without assistance and the locomotive handled it alone to the Enola yard, a distance of 127 miles. The train on arriving consisted of 119 cars, one having been set out at Huntingdon on account of a broken brass, the gross tonnage then being reduced to 8,778 tons.

This train was operated on the following schedule:

Miles.	Station.	Time Arrived.	Time Left.	Remarks.
0	Altoona .....	7.38		
25.6	Warrior Ridge .....	8.45	9.09	Took water.
...	Huntingdon .....	9.22	9.42	Set out car.
19.4	Vineyard .....	10.51	11.25	Engine cut off for water.
27	Denholm .....	12.53	2.05	Took coal and water.
26.1	"BW" .....	3.28	....	Stopped for water.
	(2.4 miles west of Bailey)			
4.1	"BD" .....		4.0	
	(1.7 miles east of Bailey)			
15.1	West End Susquehanna Bridge.		4.47	
120.0		4.47 P.M.	7.38 A.M.	Total included time.

Running time—6 hours 29 minutes.

Average speed—19 miles per hour.

This train, because of its extreme length, was fitted with a telephone between the locomotive and the cabin car and was handled under the direction of the officials who accompanied it.

**WESTERN RAILWAY CLUB.**—At the regular monthly meeting held on Tuesday, September 20th, a paper entitled "Automatic Connectors for Freight and Passenger Train Cars" was presented by Willis C. Squire.

\* See AMERICAN ENGINEER, Feb., 1910, p. 69.

## A WELL ARRANGED OIL HOUSE.

THE UNITED RAILWAYS OF HAVANA.

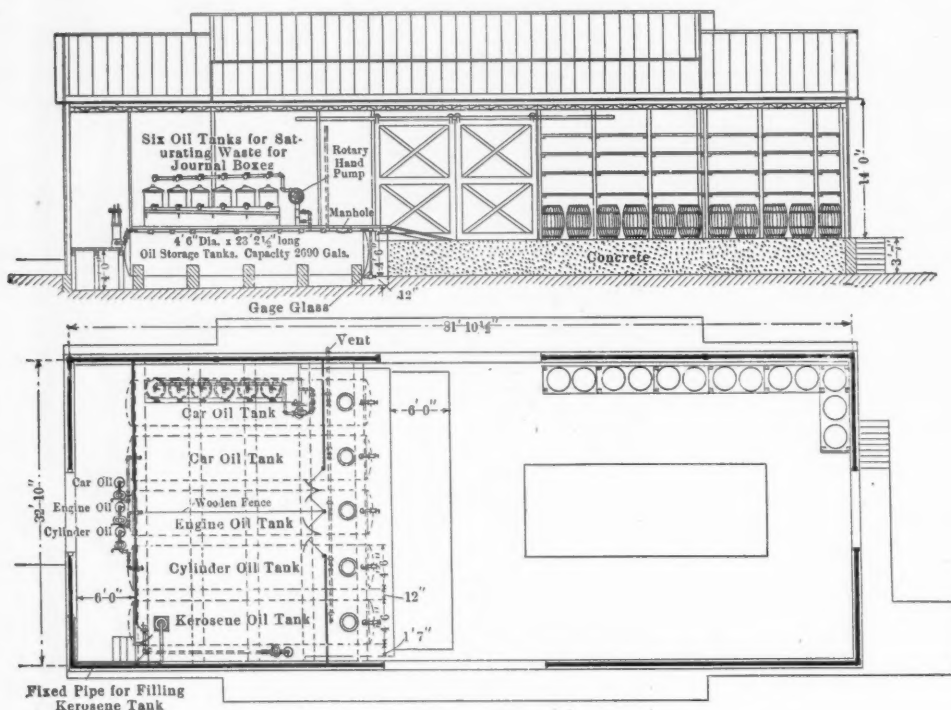
Modern oil houses have reached a stage of perfection in this country which seems to leave but little to be desired and it is

oil. The valves of the pumps are arranged so as to be easily and quickly accessible. It is provided with both side and front discharge and the rod on which the stops are located is threaded, giving a very positive measurement and adjustment. Reference to the illustration will show its general arrangement and construction.

In this oil house there are six tanks located along one side of the smaller room for saturating waste for journal boxes. In each of these tanks is a screen placed about 5 in. above the bottom, which permits the oil to drain from the waste to a trough which carries it to a dripping pan standing at one end of the row. Near this pan is a Gilbert & Barker rotary pump, which has a connection to a large tank in the basement below it, as well as to the pan of used oil. This discharges into any or all of the waste tanks, the arrangement being as is shown in the illustration.

On the other side of the building is a similar rotary pump. This pump is used for filling the kerosene cans, which are to be sent out on the road.

This equipment has proved so satisfactory that similar houses are being built at other points as rapidly as the equipment can be procured.



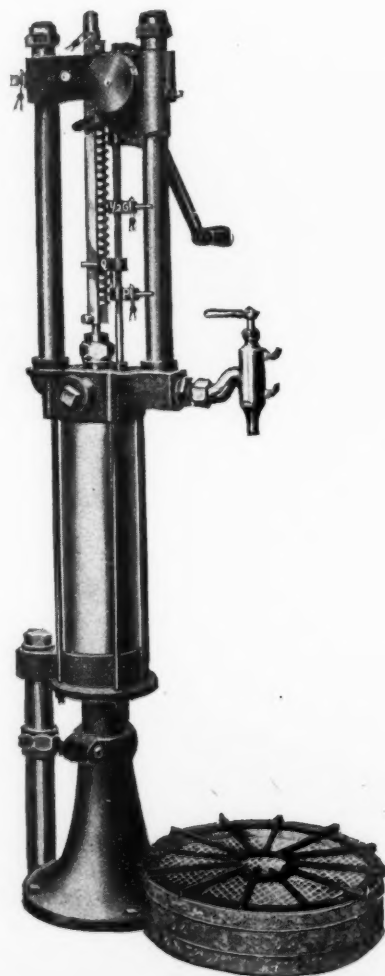
PLAN OF OIL HOUSE—UNITED RAILWAYS OF HAVANA.

satisfying to note that foreign railroads are following our example and installing commodious and well arranged structures and thoroughly modern equipment for this purpose.

An example of this is the oil house shown in the accompanying illustration, recently completed by the United Railways of Havana, which employs large storage tanks placed beneath the floor and draws the oil through a battery of self-measuring pumps. While, of course, this house is comparatively small, the equipment is very complete and the arrangement excellent. A large part of the building is given up to room for the storage of oil barrels, since most of the supply is purchased in these receptacles, and this part of the structure has a concrete floor on a level with the platform outside. There are five oil storage tanks placed beneath the raised floor of the oil room proper, each holding 2,690 gallons. Most of the tanks are filled by gravity, the barrels being rolled up an incline over the ends of the tanks where there is an opening, with a very fine screen, giving entrance into each tank. There are two tanks for car oil, one for engine oil, one for cylinder oil and one for kerosene, the latter being provided with an outside filling pipe, since this oil is purchased in bulk and delivered in tank cars.

Each tank is provided with a vent pipe carried outside the building for discharging any gases that might accumulate, and each is provided with a storage indicator scaled to gallons, which permits an inventory of the oil on hand to be obtained at any time.

Three of the pumps for the heavy oils are placed together outside of the partition, each connecting to a single tank. These pumps, as well as the whole equipment of the house, were furnished by the Gilbert & Barker Mfg. Co., 80 Fourth Avenue, New York. This pump is of the long distance self-measuring type, which accurately measures in gallons, half gallons, quarts, pints or smaller quantities at a stroke and discharges the oil directly in to the can or receptacle without the use of measures or funnels. It is fitted with discharge registers and a continuous meter, the latter registering to 100,000 gallons, and then automatically repeating. It is provided with a locking device which absolutely prevents an unauthorized person from obtaining any



TYPE OF SELF-MEASURING PUMP USED.

## HORIZONTAL BORING MACHINE

ROCHESTER BORING MACHINE CO.

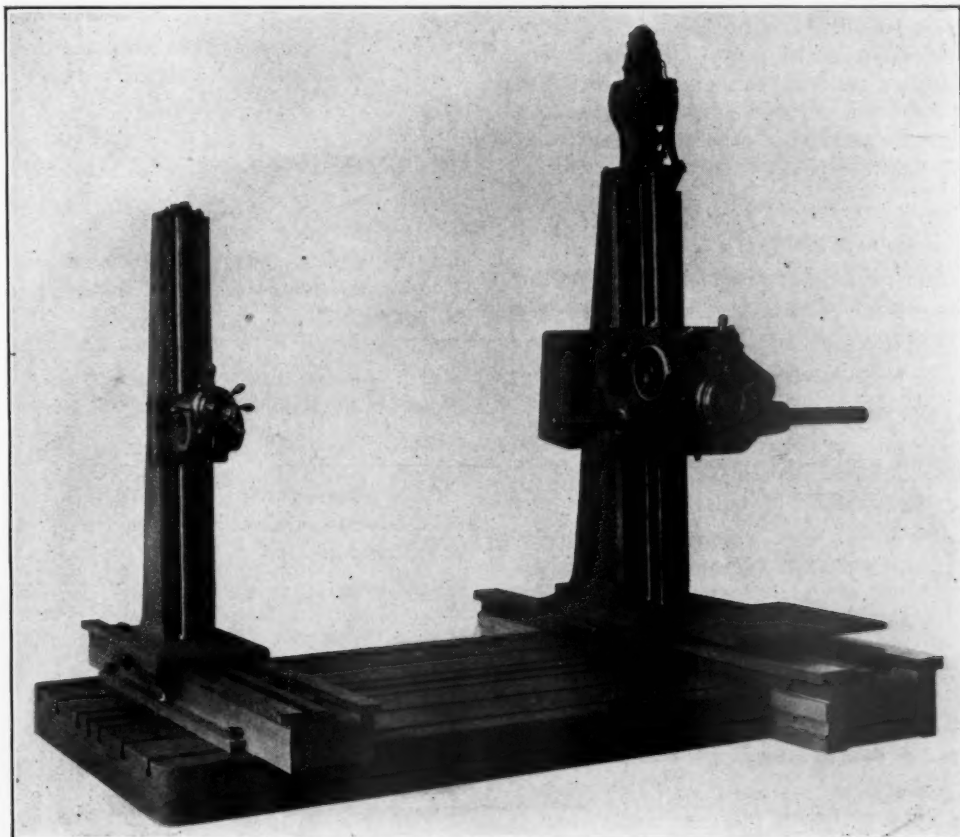
On many classes of work usually done in railroad shops a horizontal boring machine that is also adapted to drilling, tapping and milling operations, is practically a necessity. On this basis the advantages of the machine shown in the illustration will be appreciated at once. Its simplicity, compactness, ease of operation and adaptability, make it practically as valuable for each different kind of work as the regular type of machine. Although, in general appearance, the construction is comparatively light, it is very rigid and is designed for severe duty and for producing accurate work rapidly at the minimum cost.

The machine illustrated is the No. 3 Rochester horizontal, boring, drilling, tapping and milling machine, floor boring type, made by the Rochester Boring Machine Co., Rochester, New York. The floor plate, planed on the top and bottom sides, is

steel or manganese bronze, entirely enclosed in the saddle casting and fully protected. The spindle is so designed that full traverse is obtained without resetting, regardless of its length. It is journaled in long taper bearings of phosphor bronze located at each end of the saddle, adjustable from the outside, and is driven by two large spline keys fitted into a sleeve on which the driving gear is mounted.

Ten speed changes and eight feeds are available, besides four speeds for milling. An interesting feature is that all the feeds are reversible and any desired change can be instantly effected. The motor mounted on top of the column, transmits power through rawhide gearing to the vertical splined shaft, which drives the gearing enclosed in the saddle. A large number of unnecessary gears are eliminated by this arrangement, resulting in a high transmission efficiency.

An attractive feature of the entire machine is the fact that it is self contained and motor driven and can therefore be located anywhere without regard to line shafting. Further, it is very compact and simple, all the mechanism being encased in



HORIZONTAL BORING, DRILLING, TAPPING AND MILLING MACHINE—ROCHESTER BORING MACHINE CO.

provided with the usual longitudinal T slots and is rigidly attached to the heavy and firmly braced slide base by means of heavy bolts.

Graduated scales with vernier readings are provided for locating the saddle and main column in the desired positions, and the outboard support and columns are also furnished with scales giving the same readings. In addition to this, the spindle has a micrometer reading attachment for gauging depths in boring, drilling or milling. The outboard bearing is made with the same vertical and horizontal traverse as the main column, and is provided with suitable bushings for supporting boring bars. It is traversed longitudinally on the base by means of a rack and pinion remaining parallel at all times with the main slide base. The head and outboard column, as well as the main column and its saddle, are traversed by means of concentric hand wheels—both of the column traversing hand wheels being operated either by hand or power. Large and flat bearing surfaces fitted with solid taper gibs, are provided on the saddle, column and outboard support.

All the driving and feed gears are either nickel steel, cast

the saddle, and running in oil, so that all moving parts are thus fully protected and all operations are controlled from one position convenient to the work. The machine can be started, stopped or reversed independently of the motor, each movement being controlled in this manner by a separate lever which operates a friction clutch.

Some of the general specifications of the No. 3 type are given in the following table:

Diameter of spindle.....	3 $\frac{3}{4}$ in.
Longitudinal traverse of spindle.....	36 in.
Vertical traverse of saddle.....	54 in.
No. of spindle speeds.....	10
Range of spindle speeds.....	15—200 r.p.m.
Range of speeds for boring and drilling.....	.01—25 in.
Max. distance from floor plate to center of spindle.....	5 ft. 11 in.
Size of floor plate.....	6 x 9 ft.
Floor space—over all.....	9 ft. 6 in. x 16 ft. 0 in.
Weight, complete.....	10,000 lbs.

FREIGHT SERVICE THROUGH THE DETROIT RIVER TUNNEL, which connects Detroit with the city of Windsor, Canada, was inaugurated on September 15th. A ferry was formerly used between these points.

**BOOK NOTES**

Universal Directory of Railway Officials, 1910. 607 pages, 5¼ x 8¼. Bound in cloth. Published by the Directory Publishing Co., Ltd., 3 Ludgate Circus Bldg., London, E. C. Represented by A. Fenton Walker, 140 Liberty street, New York City. Price, \$4.00.

This, the sixteenth annual edition of the Universal Directory, has been very carefully revised and was entirely accurate at the time of publication a month or so ago. It contains the correct name, mileage, gauge, amount of the equipment, name and address of all officers, with their proper titles, of every railway in the world. These roads are grouped according to nations, the first being the United Kingdom, where England and Wales, Scotland and Ireland are separated. Following this are the various countries in Europe arranged in alphabetical order. Then follows the countries in Asia, also in alphabetical order; followed by Africa in the same manner, which in turn is followed by Australia. North America is then taken up, beginning with Canada, followed by Newfoundland and then the United States. Then comes Central America and South America. The roads in each country are numbered consecutively and in the back of the book is a complete alphabetical, personal index of all the railway officials in the world, giving a reference to the number of the road with which they are connected, as shown in the body of the book. To any one who has correspondence or dealings with foreign railways this book is indispensable.

**MEN WANTED**

**DRAFTSMEN.**—Several capable draftsmen and estimators by a foundry and machine company near New York City. Salary dependent upon experience and ability. Address T. I.

**POSITIONS WANTED**

**CAR AND LOCOMOTIVE DRAFTSMAN.**—Man with short experience on railroads and with car building companies wishes position as draftsman where opportunities for advancement are satisfactory. Address H. E. E.

**SALES ENGINEER.**—College grade; five years' railroad experience, principally in the shop. Address G. E. J.

**SHOP FOREMAN.**—A practical man whose experience includes drafting room, roundhouse, erecting shop and machine shop work, and who is now foreman of one of the best and most efficient shops in the country, desires a better position where ability will receive reward. Address F. G. Q.

**MECHANICAL ENGINEER OR CHIEF DRAFTSMAN.**—Long experience in the drafting room of railways; at present chief draftsman; wishes position on a southern railway. Address P. F. R.

**CHIEF DRAFTSMAN OR SIMILAR POSITION.**—Technical man, seven years' railroad experience; now leading draftsman on locomotive and electrical work on one of the largest railway systems. Address E. J. W.

**EXPERT ON MACHINE TOOL DESIGN.**—Has had long experience with the design and building of machine tools and dealing with the problems of shop production. Well equipped for duties as director of a trade school or similar work. Address S. C. J.

**DESIGNER OF RAILROAD SPECIALTIES.**—Man thoroughly experienced in railroad design now chief draftsman of one of the largest systems wishes position with a supply company handling railway specialties, that require a designer of exceptional ability. Address R. L. W.

**GENERAL INSPECTOR.**—Middle-aged man with technical education; 20 years' experience; expert on fuel, tests, spark throwing and front end arrangements; has held all positions from fireman

to master mechanic and from machinist to mechanical engineer. Address S. S.

**MECHANICAL ENGINEER OR SALES ENGINEER.**—University graduate; twelve years' practical experience as designing engineer and estimator with locomotive car manufacturers; has been chief draftsman on a large western railroad and is a specialist on steel coach calculations, designs, estimates and details. Address H. D. W.

**SALES ENGINEER, INSPECTOR OR MECHANICAL ENGINEER.**—Graduate in mechanical engineering, with nine years' practical experience in capacity of special apprentice, draftsman, chief draftsman, roundhouse foreman, mechanical inspector and chief estimator with railroads and steel car manufacturing concern. Thoroughly experienced in mechanical lines and exercising of executive ability. Address S. F. W.

**PERSONALS**

C. M. STANSBURY has been appointed master mechanic of the Ocean Shore Railway, with office at San Francisco, Cal.

R. Q. PRENDERGAST has been appointed master mechanic of the Denver & Rio Grande R. R. at Pueblo, Colo., succeeding R. B. Stout.

J. E. McLEAN has been appointed master mechanic of the Kansas City Southern Ry. at Pittsburg, Kan., succeeding George S. Hunter.

S. B. BURDELL has been appointed assistant mechanical superintendent of National Railways of Mexico, with office at San Luis Potosi, Mexico.

C. A. BRANDT has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office at Indianapolis, Ind.

C. HARDER has been appointed to succeed R. L. Langtim as mechanical engineer of the Kansas City Southern Ry., with office at Pittsburg, Kan.

J. F. WALSH, general superintendent of motive power of the Chesapeake & Ohio Ry., has had his authority extended over the Chesapeake & Ohio Ry. of Indiana.

J. L. CUNNINGHAM has been appointed master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles City, Va., succeeding G. W. Russell, promoted.

E. F. TEGMEYER has been appointed master mechanic of the Nebraska and Colorado divisions of the Rock Island Lines, with office at Goodland, Kan., succeeding D. H. Speakman, resigned.

WILLIAM GILL, instead of William Hill, as previously announced in these columns, has been appointed master mechanic of the Iowa Central Ry. at Marshalltown, Ia., succeeding C. E. Gossett.

G. W. RUSSELL, master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles City, Va., has been appointed general equipment inspector, reporting to the superintendent.

W. T. SMITH, superintendent of motive power on the Kentucky division of the Chesapeake & Ohio Ry. at Covington, Ky., has had his jurisdiction extended to cover the Chesapeake & Ohio Ry. of Indiana.

C. T. BROXUP, locomotive superintendent of the Manila Railroad, at Caloocan, Philippine Islands, has resigned.

G. J. DE VILBISS, superintendent of the motive power of the Hocking Valley Ry.; Lawrence C. Engler, road foreman of engines, and George Milbourne, engineer, were killed in the wreck of passenger train, north bound, on that road near Lemoyne, about eleven miles south of Toledo, on September 12.

### FOR YOUR CARD INDEX

*Some of the more important articles in this issue arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.*

#### Brake Levers, Design of AMER. ENG., 1910, p. 393 (October).

Curve for the rapid determination of various dimensions of brake levers.

#### Cars—Passenger AMER. ENG., 1910, p. 381 (October).

Steel Pullman Cars.

Complete description of all steel sleeping, parlor, etc., cars designed by The Pullman Co. The construction is fully illustrated with drawings and photographs. Standard underframe fits 14 types of cars.

#### Car-Truck AMER. ENG., 1910, p. 398 (October)

Description of a new cast steel truck manufactured by the Pittsburgh Equipment Co. The illustrations show detail of design.

#### Locomotive-Ash Pan AMER. ENG., 1910, p. 407 (October).

Line drawing and brief description of self-clearing ash pan used on the Pennsylvania Railroad.

#### Locomotive—Development of British AMER. ENG., 1910, p. 387 (October).

Article by R. H. Rogers discussing recent changes in locomotive design in Great Britain. Based on personal observations during an extensive visit.

#### Locomotive—4-6-2 Type AMER. ENG., 1910, p. 391 (October).

Total weight, 256,000 lbs.	Total heating surface, 4,389 sq. ft.
Weight on drivers, 162,000 lbs.	Steam pressure, 200 lbs.
Cylinders, 24 x 26 in.	Traction effort, 31,800 lbs.
Wheels, 80 in.	

Illustrated description of a very large and powerful passenger locomotive built by the American Locomotive Company for the Vandalia Line. Elevation and sectional drawings. Table showing recent service, including coal consumption and speed.

#### Locomotive—2-8-2 Type AMER. ENG., 1910, p. 405 (October).

Total weight, 263,100 lbs.	Total heating surface, 5,559 sq. ft.
Weight on drivers, 204,450 lbs.	Steam pressure, 180 lbs.
Cylinders, 23¾ by 30 in.	Tractive effort, 45,300 lbs.
Wheels, 57 in. diameter.	

Built by the Baldwin Locomotive Works for the Oregon Railroad & Navigation Co. Designed to burn lignite. Illustrations include front end, grates, firebox and the Collins pedestal binder.

#### Locomotive—Performances on Grades of Various Lengths AMER. ENG., 1910, p. 394 (October).

Article by Beverley S. Randolph investigating the effect of the length of grade on locomotive performance.

#### Locomotive—Water Tube Fire Box AMER. ENG., 1910, p. 411 (October).

Type of watertube firebox in successful use on the Northern Railway of France. Illustrated description.

#### Locomotive Terminals—Oil House AMER. ENG., 1910, p. 416 (October).

Brief illustrated description of a well arranged oil house on the United Railways of Havana.

#### Locomotive Valve Gear AMER. ENG., 1910, p. 408 (October).

A new radial valve gear designed by the Hobart-Allfree Co., based on principle of both the Marshall and Walschaert types. A full illustrated description, including dimensioned drawings.

#### Machine Tools.—Hollow Chisel Mortising Machine AMER. ENG., 1910, p. 413 (October).

Illustrated description of a new hollow chisel mortising and boring machine. Built by the Atlantic Works, Inc.

#### Machine Tools.—Horizontal Boring Machine AMER. ENG., 1910, p. 417 (October).

Illustrated description of a combined boring, drilling, tapping and milling machine of the horizontal type. Designed by the Rochester Boring Machine Co.

#### Shop Devices AMER. ENG., 1910, p. 397 (October).

Dies for shearing squares on ends of staybolts.

Brief illustrated description showing dies used at the Readville shops for shearing the squares on the ends of staybolts.

#### Shop Devices AMER. ENGR., 1910, p. 406 (October).

Valve stem turning and rolling tool.

Brief illustrated description of combined tool for turning and rolling a valve stem.

#### Superheater—Fire Tube AMER. ENG., 1910, p. 403 (October).

Used on Great Western (England) Railway. Designed by G. J. Churchward, locomotive superintendent. Six 1 in. tubes in each element. Elements connected to a horizontal header in smoke box. Description fully illustrated.

#### Train Resistance Formula AMER. ENG., 1910, p. 407 (October)

Formula suggested by Lawford H. Fry, based on Prof Schmidt's experiments. It includes factors for both weight and speed of train in one formula.

## CATALOGS.

**DRAWING INSTRUMENTS.**—Kolesch & Company, 138 Fulton St., New York, are issuing a small pamphlet describing the "Richter" precision instruments for the use of draftsmen and surveyors.

**CONTROLLERS.**—The General Electric Co., Schenectady, N. Y., has recently issued Bulletin No. 4761, which goes into some detail in describing the Sprague General Electric type "M" control system.

**VANADIUM STEEL.**—The Carnegie Steel Co., of Pittsburgh, Pa., has issued a small catalogue giving the process used in treatment of vanadium steel, including tables of the physical properties of the various types and their uses.

**RAILROAD SCALES.**—A 36 page catalogue has recently been issued by the Government Standard Scale Works, Terre Haute, Ind., describing various styles of new scales, including standard railroad track scales with capacity of 60 tons and up.

**SNOW PLOWS.**—Bulletin No. 1005, issued by the American Locomotive Co., New York City, describes its rotary snow plows very fully, including illustrations of these plows at work making cuts 24 ft. deep. It also gives a list of railroads that are users of this design of rotary plow.

**SMALL GENERATORS.**—The Triumph Electric Co., Cincinnati, O., has recently issued new Bulletins Nos. 391, 411 and 421, describing its direct current steel frame generators and motors and small direct connected generator sets with vertical type engines. The capacity of these machines is up to 100 k. w.

**TOOL HOLDER.**—A small circular is being issued by the G. R. Lang Co., Meadville, Pa., describing the various styles of its new tool holder for shapers, boring mills and lathes. It includes a number of illustrations showing the application to the various machines, and adaptability for all classes of work.

**METALLIC PACKING.**—This is the subject of a new 40 page catalogue issued by the Holmes Metallic Packing Co., of Wilkes-Barre, Pa. It contains a description of packings for all purposes, with illustrations showing their application and a large amount of data on the life of these packings in service on locomotives.

**CONVEYING MACHINERY.**—Coal handling equipment and machinery, the subject of a new Bulletin No. 42, issued by the Jeffrey Mfg. Co., Columbus, O., contains a number of illustrations showing the various styles of coal handling machinery, one section being devoted to locomotive coaling stations and their equipment.

**AIR COMPRESSORS.**—Publication 391, issued by the National Brake & Electric Co., Milwaukee, Wis., consists of a 68 page catalogue with tables and a large number of reproductions from photographs, and diagrams showing National motor driven air compressors and also some well designed portable air compressor outfits.

**VALVE GRINDER.**—The catalogue issued by the Turner Machine Co., Philadelphia, Pa., illustrates and describes some of its automatic valve grinding machines, including moulding machines and foundry equipment. The valve grinding machines are valuable in saving labor and time, especially when used for grinding air brake cocks.

**PORTABLE ELECTRIC DRILLS.**—The Sprague Electric Co. has issued small bulletins describing its electric drills for direct and alternating current. The power required is roughly 104 watts when operating a  $\frac{1}{8}$  in. drill in machine steel at a feed of about 4 in. per minute. There are also illustrations and descriptions of small motor driven disc and propeller fans.

**HIGH SPEED DRILLS.**—Catalogue No. 10 on this subject is being issued by the Celfor Tool Co., Railway Exchange, Chicago. The catalogue is attractive and well illustrated, going into detail in the process of manufacture of these drills. It contains a large table with valuable information regarding the feed and speed of the drills for cast iron, medium and hard steel.

**DRILLS AND HORIZONTAL BORING MILLS.**—The Fosdick Machine Tool Co., Cincinnati, O., is issuing an attractive and well illustrated catalogue giving descriptions and complete specifications of its universal and plain radial drills, with arms up to 5 ft. in length, and also various styles of horizontal boring, drilling and milling machines, which are adapted for all classes of work.

**THE MECHANIGRAPH.**—Topping Bros., 122 Chambers St., New York City, have recently issued an attractive catalogue describing and illustrating their new process of making drawings transparent so that blue prints can be made directly from the original drawing. It also describes a machine for renovating old worn out tracings without affecting the original lines of the drawing.

**STEEL CAR PAINT.**—The Joseph Dixon Crucible Company of Jersey City, N. J., has just issued a very attractive little booklet of envelope size on their paint for steel cars. The booklet not only goes into the merits of the Dixon paint for this service, but illustrates a number of different types of steel cars upon which Dixon's paint has given excellent service. The booklet also contains color chips showing the four colors in which this car paint is made.

**NON-CORROSIVE SHEET METAL.**—A comprehensive treatise on the corrosion of steel and iron is issued by the Stark Rolling Mill Co., Canton, O., makers of Toncan metal. The treatise sets forth, clearly and concisely, the facts concerning corrosion and rust, their causes and remedy. Some interesting comparisons are made of old-time iron and modern iron and steel, showing the effect of purity, homogeneity and density on its life and including the uses of a rust-resisting product like Toncan metal.

**HIGH PRESSURE BLOWERS.**—Catalogue No. 175, issued by the B. F. Sturtevant Co., Hyde Park, Mass., illustrates and describes a variety of horizontal impeller type blowers suitable for gas or oil burners, including annealing furnaces and metal melting furnaces. Some of these blowers are direct connected to engines or motors by a flexible coupling of leather links to take care of any defects in alignment and end thrust. The capacity, at  $1\frac{1}{2}$  lbs. pressure, ranges from 25 to 15,000 cu. ft. per minute with 200 to 800 revolutions per minute, but the blowers are recommended for pressures up to 5 lbs.

## NOTES.

**UNITED ENGINEERING & FOUNDRY CO.**—Otis H. Childs, chairman of the executive committee and a director of this company, of Pittsburgh, Pa., died on August 22.

**SAFETY CAR HEATING & LIGHTING CO.**—It is announced by this company, of 2 Rector St., New York, that John J. Malloy has been appointed general purchasing and supply agent and will have charge of all departments heretofore under the direction of Mr. Pye.

**S. F. BOWSER & CO.**—This company, of Fort Wayne, Ind., announces the appointment of Edward H. Barnes at Atlanta, Ga., as representative of the Southern district. Previous to his appointment Mr. Barnes was associated with the Bass Foundry Machine Co., Fort Wayne, Ind.

**HOMESTEAD VALVE MANUFACTURING CO.**—The above company, of Pittsburgh, Pa., has opened an office at 1135 Park Row Building, in New York City, N. Y., in charge of Frank Boyle, for the sale of Homestead valves in this territory, and will carry a stock of valves for immediate delivery.

**ROCKWELL FURNACE CO.**—To accommodate the increasing business in the Middle West, this company, of 27 Cortlandt St., New York, has opened a branch office in the Fisher Bldg., Room 718, Chicago, Ill. The office will be in charge of A. L. Stevens, an experienced furnace engineer, and will enable the company to give more prompt attention to the Western trade.

**FIRTH-STERLING STEEL CO.**—E. S. Jackman & Co., agents for the above company, announce that James A. Sherwood, who for the past five years has filled a responsible position in the sales organization of this company, has been appointed the Canadian agent for Thomas Firth & Sons, Ltd., Sheffield, England. Mr. Sherwood will have full charge of the Canadian trade beginning October 1, with headquarters in Montreal.

**WELLS BROS. CO.**—The above company, of Greenfield, Mass., announces the opening of a new store in New York City at 90 Worth St., and the stock of tools which was formerly carried at 126 Chambers St. has been moved to the new store. A full and complete stock of screw cutting tools will be carried, so they are ready for immediate delivery on special rush orders. The new store will be managed by Chas. H. Coe, formerly with A. Z. Boyd, of New York City.

**H. W. JOHNS-MANVILLE CO.**—Owing to the increased business in the vicinity of Atlanta, Ga., and Rochester, N. Y., the above company, of 100 William St., New York, has recently found it necessary to open a new office in each of these cities. The Atlanta office is located in the Empire Bldg., in charge of W. F. Johns, who has been traveling in this territory for the company for a number of years, and the Rochester office is located at 725 Chamber of Commerce in charge of H. P. Demoiné, formerly with the Buffalo branch of the company.

**AMERICAN LOCOMOTIVE CO.**—The annual report to the stockholders of the company for the fiscal year ending June 30 has recently been issued by the board of directors. It is interesting to note that the net earnings were \$2,597,949, as compared with \$1,342,671 in 1909, and the surplus was \$334,758, as compared with a loss of \$762,860 last year, showing an improvement in the net results of \$1,097,619. At the beginning of the fiscal year the company had unfilled orders on its books amounting to \$6,150,000. And on July 1st, 1910, the amount was \$17,550,000.

# Locomotive Boilers

A REVIEW OF REPORTS PRESENTED AT THE RECENT RAILWAY CONGRESS ON THIS IMPORTANT SUBJECT, WHICH INDICATE A LACK OF UNIFORMITY IN PRACTICES AND LITTLE PROSPECTIVE IMPROVEMENT.

A thorough consideration of the question of improvements in locomotive boilers brings to light curiously divergent views entertained by designers, and clearly indicates, from the standpoint of universal application at least, that many problems must still be solved before general uniformity in prominent details of construction will be attained. In American practice it is admitted that the latter condition practically prevails, but in comparison with ideas covering the same operations which are entertained in foreign countries the difference exhibited is startling to a degree, when the similarity of the work which the apparatus must perform, no matter where located, is borne in mind.

It may necessarily be regarded as elementary in view of this treatment to assert that primarily a boiler is intended to make steam in sufficient volume for the work at hand, and that this is its mission in whatever country, but some freaks in its design and some peculiar variations in the operations connected with its maintenance as exhibited in various lands might almost impel the thought that a different appliance was under consideration.

This was well exemplified during the recent Eighth Session of the Railway Congress when reports on boiler design and the care of boilers were submitted from railroads in every country of the world, with the possible exception of China, Egypt, Greece, Dutch Indies and the Congo. A careful reading of these voluminous bulletins indicates that the greatest divergence of opinion exists in the treatment of many items entering into boiler construction, but particularly in connection with the material and the shape of fireboxes, the material for tubes, and their mode of application and repair; the practicability or utility of superheaters, and of the value of water tube boilers. Many examples of curious practices were also presented, but it is thought that a discussion of the above principal features may prove of greater interest.

To explain the assertion that uniformity in detail of construction is present in this country it may be well to recall that the type of boiler generally used in the United States and Canada is that with a round top firebox of what is termed the extended wagon top style, in which the diameter of the circular portion of the firebox and the rear portion of the barrel is larger than that of the front portion of the boiler. Usually the course of the boiler next to the firebox and the front course of the boiler are both cylindrical in form, joined together by a middle taper course. The dome is usually placed on the course next to the firebox. A few of the larger railroads, such as the Pennsylvania lines, including allied roads, and the Great Northern are using the Belpaire firebox, while others, such as the Illinois Central and Canadian Pacific railways, have used the Belpaire more or less extensively, but in each case the latest engines have been equipped with round top boilers.

As very clearly put by H. H. Vaughan in his report to the Railway Congress on American practices the extensive use of the round top fire-box is explained by the results from it being on the whole satisfactory. The Belpaire form of box has, no doubt, an advantage in the fact that the stresses in the various plates and stays can be accurately determined by calculation, whereas in the round top boiler, especially one of the radial stayed type, these stresses cannot be determined with the same degree of accuracy. The service, however, of many thousands of round top boilers has fully demonstrated the safety of this type when properly constructed and maintained, and has proved the correctness of the calculations by which their strength is determined. The Belpaire fire-box is somewhat more expensive to construct than the round top, and adds a certain amount to the weight of the boiler without a corresponding increase in

the heating surface, hence the largely predominating use of the simpler round type.

## ROUND TOP BOILER THE STANDARD.

In view of the fact that this latter construction is so greatly in the majority on American roads, it may be assigned as the "standard" type, and in this connection it is of interest to review briefly the opinion in which it is held abroad. It is quite singular, in view of the popularity which the round top boiler enjoys here, to find it utterly repudiated in France. The chief French railways have adopted Belpaire boilers on all their more recent locomotives, with the exception that the Paris-Lyons-Mediterranean is designing a single Pacific locomotive with a round top boiler. M. Nadal, Chief Engineer of the French State Railways, does not explain why the round top boiler is not preferred, contenting himself merely with the non-committal statement, "Each of these two types has its own advantages and disadvantages, and these have been the subject of much discussion. It must finally be recognized that neither the one nor the other is very definite, but the round top boiler is more extensively used, and it appears to be preferable in the case of large boilers."

As an illustration of the extensive use of this type abroad it may be mentioned that in Austria-Hungary, Roumania, Bulgaria, Servia and Turkey the boilers of the more recent locomotives are round topped. Belpaire boilers are occasionally to be found on older locomotives in those countries, as well as flat tops of the Becker and other similar types. In Russia it is practically the standard, and is generally preferred in Holland, Sweden, Switzerland, Bavaria, Prussia, Denmark and Norway. Great Britain exhibits many boilers of the Belpaire type, but a careful analysis indicates about a two-thirds majority in favor of the round top.

It is unfortunate, in view of the interest which so generally attaches to boiler construction at this time, that with the exception of what is contained in Mr. Vaughan's valuable paper the reporters of the various countries at large did not assign any definite reason for the preference toward either type. It is confidently believed that locomotive design in England at present is in the throes of a radical metamorphosis: this based on the many and diversified experiments which all roads are conducting, therefore reticence may be reasonably looked for in that quarter, but in the instance of the other countries the same condition does not apply, and there is no real reason why the conclusions which dictated the choice in favor of the round top boiler should not be apparent. However, enough has been gained at least to establish the fact that this latter type is overwhelmingly in the majority all over the world, and that in one item, the outer shell, there is a prospect of ultimate uniformity.

## WIDE LATITUDE IN FIREBOX MATERIAL.

In the matter of fireboxes proper great diversity of opinion exists in regard to the material from which they should be made. They are exclusively of steel in this country, but the preference for copper abroad is seemingly too deeply rooted to be overthrown for many years. In Austria-Hungary, Roumania, Bulgaria, Servia and Turkey copper is generally employed. Trials of iron fireboxes have been made on several railways therein, and some are still the object of trial at present. For instance, the Austrian State Railway has a number of ingot-iron fireboxes, and also iron water tube boxes of the Brotan system. Both are said to give good results in the trials which have now been going on for four or five years.

A number of years ago the Hungarian State Railway tried

five fireboxes made of ingot iron, but these had to be taken out after they had been in use a comparatively short time and replaced by copper fireboxes, because they showed cracks and serious rusting in their lower portions. A firebox on that road is at present being fitted with a crown sheet of ingot iron. The iron fireboxes also did not give good service on the Austrian North-Western Railway, and had to be taken out because cracks formed. The Austrian Southern Railway has experimented with ingot iron fireboxes made from corrugated plate, on the Hasswell system, and also for a short time with copper fireboxes having the tube plate of ingot iron. The results, however, were unfavorable, as cracks and fissures appeared: in some cases during the fitting, in others while in use, and it was found that the fuel used (coal) acted on the material and produced a chemical change which affected the strength and durability of the plate to a material degree. These trials were accordingly stopped, and the copper firebox permanently re-established.

Copper practically rules in Russia for this purpose, but extensive experiments have been made with other material. Fireboxes with iron side sheets may be encountered on the Viaducalcaucas line, which has 302 locomotives out of 809 so equipped. Up to the present the results are said to have been good, with the exception that the use of hard water results in corrosion of the iron plates. Eight other roads in that country are using iron as an experiment for the fireboxes, partly in the form of full sheets, and partly for tube plates and back plates. The results of these experiments vary; that is, they are good on lines where the water has not more than 24.7 English degrees of hardness, and bad where the water has from 24.7 to 111 degrees of hardness. The iron plates require more looking after than the copper owing to leaky tube troubles, and apparently this consideration will result in the total abandonment of any material other than copper.

In France the fireboxes remain of copper and there is little likelihood of any change, although there are isolated instances where several railways are experimenting with boxes made entirely of steel following the American practice. Two locomotives on the French Northern were recently fitted up in this way, but beyond the statement "The application is too recent to enable any conclusions to be drawn as yet," there is no augury for the future. Although the Midi has fitted a considerable number of engines with steel crown sheets which are giving good results and afford satisfaction, the French engineers retain prominently in mind the fact that the Paris-Lyons-Mediterranean a dozen years ago tried fireboxes made wholly of steel with very unsatisfactory results owing to the cracks which very quickly formed in the stayed portions.

During the last two years the French State Railway has been trying on two locomotives having working pressure of 185 pounds and of 213 pounds, respectively, tube plates with that part which receives the tubes made of steel, and the lower part made of copper. In this ingenious but certainly questionable arrangement the two parts of the tube plate are joined by a lapped seam, the copper being on the side toward the fire, so that it can be caulked, and with the seam a little higher than the arch. Up to the present time these compound plates are said to have given good results, but it is necessary to give the seam a frequent caulking, and some of the rivets have been replaced.

Steel fireboxes have not been found satisfactory on the Italian State Railway where they are embodied in the American built engines which are running there. These engines have  $\frac{1}{2}$  in. tube plates and  $11/32$  in. crown and side sheets. In referring to the performance of these boxes M. Nadal states that the results have not been satisfactory, without further comment.

#### FAILURE OF INGOT IRON BOXES.

By far the most interesting experiments, however, to determine the most enduring and in general satisfactory material for this purpose were conducted on the Bavarian, Saxon, Dutch and Prussian railways, and the general result has been a return to the former practice where copper was universally employed. The Bavarian State Railway was supplied in 1900 and 1901 with two freight and two express engines built in the United States,

which had fireboxes of ingot iron. The boxes in the freight engines had to be renewed after four years, and again after three years. The second time copper fireboxes were substituted. In regard to the express locomotives, one had its iron firebox replaced after three years by a copper box, and the other after six years. The ingot fireboxes gave good results when first used; afterwards corrosion appeared inside, particularly at the points in contact with the fire, and also cracks, which started from the staybolt holes. These latter enlarged at an alarming rate, and made it necessary to dispense with the boxes. Further experiments have not been made by this road.

Trials were made with ingot iron boxes on the Saxon State Railway during 1892-1902, but in consequence of corrosion and pitting the copper came quickly back into its own. This material had also a trial on the Dutch and Danish State railways, but little durability was shown and consequently no further experiments were made with them. At present this latter line is conducting tests with iron tube plates in copper boxes, and also with fireboxes made of "hard copper" and "special copper," this being supplied by the firm of Heckman of Duisburg.

Fireboxes made of ingot iron and nickel copper have been tried on the Prussian-Hessian State Railway. Trial previously made with ingot iron fireboxes gave results which were so unfavorable that in 1896 it was practically decided that such fireboxes should not be used. Their average life was only three years, and much less under unfavorable conditions, particularly where bad water was present. In one instance the box lasted only six months. It was also found that during use cracks appeared, not unfrequently in the firebox walls. Not only was it difficult to repair these, but in a number of cases it involved much expenditure and loss of time. Although the use of ingot iron fireboxes has been again recommended in certain quarters, it is practically assured that nothing will materialize, and chiefly on account of the bad result obtained in Bavaria.

Continuing its experiments, the Prussian-Hessian State Railway has installed fireboxes of nickel copper in a simple freight engine and a compound freight engine. The nickel proportion is about 15 per cent., and the boxes were applied in the summer of 1905. When the simple engine was carefully examined in 1908 it was found that the side corners of the tube plate had been considerably affected by the fire, and several rivet holes showed cracks; in particular the left corner of the back plate was defective. In order to make repairs permitting the use of the locomotive it was necessary to apply copper patches 19 in. long at the damaged spots. The side sheets and the crown sheet were still in good condition.

No report on the condition of the compound engine which was fitted out at the same time is given, but from the condition of the other engine the conclusion may readily be drawn that nickel copper is an unsuitable material for fireboxes, for although it costs much more, it presents no advantages.

#### PROHIBITIVE COST OF NICKEL COPPER.

Figures assist facts, and in passing it may be well to slightly comment on the enormous cost of nickel copper over ordinary copper, and the cost of the latter is reckoned in United States as sufficient to render its use prohibitive. While recently in France the writer made a calculation in the shops of the Chemin de Fer du Nord that if a nickel copper firebox were to be applied to an engine waiting there to receive one of ordinary copper the increased cost would be 4,800 f, or nearly \$1,000. This is merely the cost of material and does not consider the labor and the increased cost of the latter in this connection is no inconsiderable factor, as the nickel copper is much harder, takes longer to work, and must be handled with exceeding care in the preliminary operations.

Copper used for fireboxes in foreign countries generally is either smelted or obtained electrolytically, but it must be regarded as doubtful whether electrolytic copper is quite as good as smelted copper, as regards durability and resistance to burning, particularly in the corners where this trouble is usually in evidence. It is interesting to note in this connection that the Prussian-Hessian State Railway specifies that the copper plate

used for fireboxes shall have an ultimate tensile strength of at least 31,200 lbs. per square inch of original cross section, and an elongation of at least 38 per cent., measured on a length of  $7\frac{7}{8}$  in. The metal to be tested may not be heated, and the test pieces have accordingly to be cut and machined cold.

This somewhat lengthy comment on the subject of fireboxes alone was inspired through a considerable respect for the costly experiments which are frequently observed abroad and which have for the sole end in view the acquisition of the proper material regardless of the cost of the tests or of the future permanent costs which would be imposed through the substitution of such material as nickel copper. The matter was quickly settled in the United States, as we all know, where steel is universally used for fireboxes, but whether it is considered that the problem has been solved is not within the province of this article to discuss. Fireboxes last on an average about ten years in this country in good water districts, and from two to four years in sections where the water is bad. In view of the high earning capacity of locomotives at home this, no doubt, is considered to be a good return for the investment.

It would certainly appear on its face that firebox steel of good grade, for instance, taken at random, the Pennsylvania or Baltimore and Ohio specification, should prove adequate for the much lighter service in the old country whose worst water does not compare with certain portions of the United States, and where locomotives are accorded much better maintenance, if the last must reluctantly be said. However, the fact remains that with the single exception of Spain, fireboxes made wholly of steel are not in favor abroad, but it may be that what is being accomplished there on a small scale may attract sufficient attention to give them a thorough and proper test. In 1907 the Lorca-Augilas line of that country fitted, as an experiment, two boilers with steel tube plates, and as these gave satisfactory results in every way, it was decided to adopt all steel fireboxes, the first of which was taken into use in August, 1908, of course too short a life to warrant any expression from that road concerning their permanent retention.

#### DECLINE OF THE BRASS TUBE.

Boiler tubes in this country are almost exclusively of charcoal iron, while abroad the usual lack of uniformity so noticeable in connection with other details looms with equal prominence. On the roads of Belgium, Spain, Italy and Portugal and France they are of iron, of mild steel or of brass. In Russia the material used is exclusively ingot iron. In every country there is a discrepancy and no agreement in regard to the best practice. One thing, however, has been clearly established through the work of the last Railway Congress; and that, the gradual decline of the former time-honored brass tube.

Fortunately in the consideration of this item reasons are given for their retirement, of which the following are presented: The railroads of Austria-Hungary, Roumania, Bulgaria, Servia and Turkey agree that the use of brass tubes was abandoned, and quite apart from their high cost, because when lighter fuel (lignite) was used, the tubes became worn quickly and irregularly, until they finally collapsed and broke, consequently the above countries have adopted ingot iron or mild steel. In Russia they are made exclusively of ingot iron, through the contention that this material, which is much cheaper than brass, works very well, requires no special maintenance, and, as regards conductivity, is practically equivalent to brass.

In France mild steel is exclusively used, and for these reasons: Mild steel tubes cost less than brass tubes; they produce smaller strains in the tube plates, because the coefficient of expansion of steel is less than that of brass; brass tubes do not resist pressures of over 170 pounds per square inch satisfactorily; the ends of the steel tubes are very easily repaired by autogenous-soldering methods; and, the firebox ends of tubes made wholly of brass are rapidly corroded; safe ends of copper and ferrules have to be added, which ends are expensive and give rise to fracture. It is agreed in France that the steel tubes become pitted and corroded more quickly than brass tubes, if the water is of bad quality, but these results are not apparent, as the water is uniformly good.

#### VARIABLE FLUE SETTING AND SPACING.

So far as the setting of tubes is concerned practices abroad do not vary greatly with those in evidence in this country. The railways which use steel tubes do not use ferrules, while those who have kept brass tubes resort to this latter practice in order to protect the end of the tube against the action of the fire and to improve the tightness. In this case the thickness of the ferrule varies between  $3/32$  in. and  $5/32$  in. The steel tubes employed are nearly everywhere beaded, at all events in the firebox end, and often at the smoke box end. In the instance of brass tubes the practice of beading is much less general. On the Belgian State Railway the brass tubes are beaded, while this is not done on the Italian railways and on the majority of secondary railways. But the Italian railways have now for quite a considerable period been trying special ferrules with a flange, this in order to protect the ends of the tubes against the flames, and this would show that such a protection is considered necessary.

Flue spacing may perhaps be of greater interest than the mere setting of the tubes in the sheet, which, as has been said, does not vary greatly from American practice, and in this item also will be found a remarkable lack of uniformity; in fact, it may be said that the procedure is practically at random. It would appear, indeed, from even a casual examination, that the order in which the tubes are set varies so much on different railroads that little importance is attached to the matter in general. On the French Eastern the tubes are set in, and expanded in horizontal rows, alternately from right to left, and from left to right. On the French Northern the work is done in vertical rows, starting from the middle, and then doing a vertical row on the right and on the left alternately, but always going from the top to the bottom. Experience would seemingly show in this procedure that to drive the metal toward the edges is the best for avoiding deformations of the tube plate. On the Midi Railway the work is done in horizontal rows, starting from the bottom. On the Paris-Lyons-Mediterranean it is performed in vertical rows, starting from the extreme left, or the extreme right row, but always starting at the top. On the Belgian State Railway, and many others throughout Europe, no particular order is adopted.

It will be noted after careful consideration of these vagaries in tube setting that in this regard conditions approach closer to our own practice than any which have been heretofore touched upon. For instance, some roads in the United States insist that all tubes shall be beaded in the front end; others that only a small proportion be beaded in "x" fashion across the front tube sheet, while others contend that it is a waste of money to bead them in the front end at all. In the back end, particularly in new construction, it is sometimes insisted that all tubes be prospered, but instances are not uncommon where the railroad inspector stationed at the builder's shop has been instructed not to allow the use of a prosper or any similar contrivance.

#### THE BROTON BOILER POPULAR.

Experiments with water tube boilers on an extensive scale are clearly indicated in the reports from foreign roads, a departure which has received little or no encouragement in American practice. The protracted and expensive repairing of boilers, making it necessary to lay up the locomotive for weeks, led Mr. G. Nolte, a prominent Russian engineer, to a consideration more than twelve years ago of the possibility of replacing the usual locomotive firebox by one of new type with water tubes. The idea thus originated with Mr. Nolte, although he was delayed in his experiments until Chief Inspector Broton, works manager of the Austrian State Railway, brought out the boiler which now bears his name.

This boiler was unquestionably well designed and carefully thought out. It is the only kind of water tube boiler used in Austria-Hungary, Roumania, Bulgaria, Russia, Servia, Turkey and other countries. The construction of this boiler is no doubt generally understood, but it may be briefly described as a combination of fire tube and water tube boiler, for the barrel, together with the smoke tubes and the two tube plates is of

the same design as in the ordinary locomotives used until now, while the firebox can be considered as a water tube boiler. A further peculiarity of the Brotan boiler is that a steam chamber and upper drum are placed above the barrel, and the firebox. The firebox and the firebox shells of the ordinary boiler are replaced by vertical water tubes made of iron and placed next each other, extending from one common foundation ring to the upper boiler. These tubes, which are spaced closely, form the walls of the firebox, while two other tubes enable the water to flow from the barrel through the foundation ring and the firebox tubes into the upper drum.

Having two tubes connected with the barrel has made it possible to avoid connecting both longitudinal sides of the foundation ring or tube. This is an appreciable improvement over the original design, where only one tube was used. In the present design, now in great favor, the foundation tube consists of but four parts, which are united by three flange joints into one whole.

#### ADVANTAGES CLAIMED FOR WATER TUBES.

As water entered the fire box water tubes from below, steam is able to rise very freely without forming vortices; and, as the mixture of steam and water which is in the tubes has a materially lower specific gravity than the entering water, the circulation of the water is much facilitated in this design. The quicker and more economic production of steam in the Brotan boiler has been attributed to this circumstance, together with the thinner fire box walls. It has been shown, however, through conclusive tests that the thickness of the walls of the heating surface is of quite subsidiary importance; consequently the more economic working of the Brotan boiler can only be attributed to the better circulation of the water and to the greater direct heating surface which results from the circular cross-section of the tubes and from their staggered arrangement.

These boilers are highly regarded in all foreign countries where employed, in particular the results obtained on the Moscow-Kazan Railway show that Mr. J. Brotan's assertion that a boiler of this design works more economically than the ordinary boiler has been fully proved. The reports in question indicate that the Brotan boiler gave an economy of 14.43 per cent. in the coal consumption, this result being so surprising that it was checked in a number of carefully executed trial runs before being accepted as conclusive.

That this novel design possesses many points of merit goes without question, and the continued success of the type cannot fail in shortly attracting universal attention. This combination of fire tube and water tube boiler has a very large water space and a sufficiently large steam space; the water circulates well and consequently evaporates quickly, hence the formation of scale in the tubes is effectively prevented by the active movement of the water. The system of construction is strong, and there are no particular difficulties in the maintenance, at least whatever these may be they are less than with the locomotive boilers used abroad, containing a copper fire box. The boilers give good results as regards steam production and the keeping up of pressure, items of special importance in the case of long runs.

#### SUPERIORITY OF BROTRAN TYPE.

General conclusions from many roads in the countries named, which are using this type of boiler are as follows:

First.—With proper attention the Brotan boiler works reliably and economically. The smaller amount of water consumed by locomotives equipped with Brotan boilers shows, contrary to earlier expectations in connection with the formation of steam in the boilers, that drier steam is produced than by locomotive boilers of the ordinary pattern.

Second.—As the two tube plates are riveted to the barrel of the boiler which does not give in the longitudinal direction, it appears that the fire tubes are more rigid in the boiler than is the case in the usual system of construction, and which gives them a tendency to leak.

Third.—Repairs found to be necessary in the Brotan boiler

can be carried out easily and quickly, this being a positive arrangement in this system of construction.

Fourth.—The Brotan fire box gives the frame no support and consequently it is necessary to provide other stiffening for it.

Fifth.—The Brotan boiler works more economically than the ordinary boiler. The calculated coal economy is 2 to 5 per cent., but in practice it has been found to be 10 to 14 per cent. The reasons for this discrepancy have not as yet been ascertained with certainty.

Sixth.—As the majority of boiler explosions are caused by a defective condition of the fire box walls, the Brotan boiler may be looked upon from this point of view as safer.

Seventh.—The Brotan boiler is about 15 per cent. cheaper than the ordinary boiler.

Eighth.—The general results obtained show that the use of the Brotan boiler is to be recommended.

There is little doubt but that the United States will hear much more of this type of boiler. A careful review and study of all reports presented at the last Railway Congress clearly indicate it to be the most successful of all radical departures in design during the past few years. It seems to have solved the problem of fire box troubles, which has not been the least vexatious to confront American railway management.

Other interesting points touched upon, and in some instances discussed at length, were superheaters, concerning which the general opinion abroad favors their retention and further development; rocking grates, the adoption of which is generally advocated, and washing out of boilers. In this latter detail the usual variation of opinion was in evidence, but the majority favored cold water for the operation.

These are the principal features in connection with boiler design and improvements touched upon in the reports submitted to the last Railway Congress, and it is believed that no more interesting matter has ever come before that body. They point conclusively to what this article at first intimated: that items of boiler construction presumed to be definitely settled in this country are still in the experimental stage abroad, and they indicate that a continuance of these experiments, particularly in the development of the water tube boiler, may unearth at any time something which can be advantageously employed in our own practice.

## THE ELECTRIC RAILWAY CONVENTION

The annual convention of the American Street and Interurban Railway Association, held at Atlantic City, October 10-14, was the most successful in the history of the association and reflected great credit upon everyone who assisted in the arrangements. The total number of members and guests was considerably over two thousand, representing the various accountants, engineering, claim agents, manufacturers and traffic and transportation associations which are affiliated with the American association.

The various exhibitors numbered upwards of two hundred, and in variety the exhibits included every possible item of interest to street railway men. These occupied three buildings, and also the aquarium court and the machinery hall of the million dollar pier. The track exhibits were placed on a temporary track, 250 feet long, parallel to the boardwalk and extending north to the pier. It is doubtful if a more generally attractive display has ever been previously gathered in the convention city. No hitch whatever occurred in connection with any exhibit, all being ready on the opening day of the convention.

The following officers were elected for the ensuing year: President, Arthur W. Brady, president Indiana Union Traction Co., Anderson, Ind.; first vice-president, Thomas N. McCarter, president Public Service Railway, Newark, N. J.; second vice-president, George H. Harris, Washington Railway and Electric Co., Washington, D. C.; third vice-president, Charles N. Black, vice-president and general manager United Railroads of San Francisco; fourth vice-president, W. G. Ross, managing director Montreal Street Railway.

### TEST TO SHOW THAT NEW CHILLED WHEELS ARE NOT TRULY ROUND

That new chilled car wheels ordinarily embody two distinct defects, uneven chill and tread not truly round, was somewhat prominently featured by Thomas D. West in a paper before the recent meeting of the American Society for Testing Materials. This paper was of value in attracting attention to these conditions, especially the latter, which is not believed to generally receive much consideration.

It is, of course, well known that perfection has not been attained in either detail. The chilled question, in fact, has been made a special study by many qualified experts, among them the late Dr. C. B. Dudley, and many changes in existing methods of casting have been advocated to insure against variation in the depth of the chill. The detail of true circular form, however, has not been given so much attention, and had it not been for careful tests recently made by S. K. Dickerson, assistant super-

a solution to the vexatious problem of accounting for the presence of a mysterious flat wheel, after very light service, and when none of the usual contributing causes could be satisfactorily assigned. The same also applies in the instance of Fig. 4, in which, while the deformation is not so prominent, it is, nevertheless, clearly in evidence between points .019 in. and .026 in.; in fact, all of the wheels represented in the diagram are worthy of careful study, not to mention the interesting field for speculation afforded in the consideration of what bearing the irregularity may have on the life of the wheel.

The tests effectually demonstrated the necessity for improvement in the roundness of car wheels, and it is believed that if generally applied by railroads it would result in the failure of many wheels to pass satisfactorily. The lack of roundness prevents smooth running and must cause vibration or pounding which greatly adds to the liability of rail fractures.

Reverting to Mr. West's paper, he mentions that he has conducted many experiments with his own method to secure a uniform chill, the results of which demonstrated the urgent need

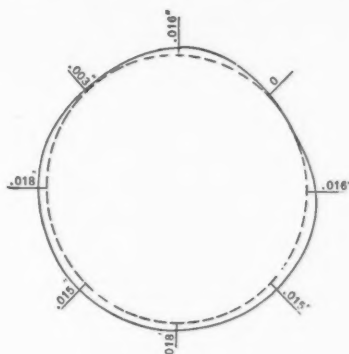


FIG. 1.

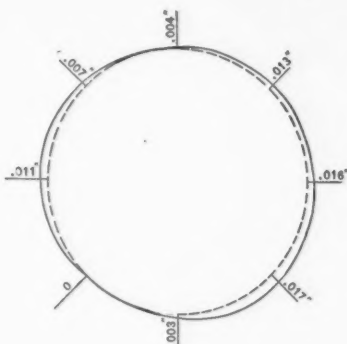


FIG. 2.

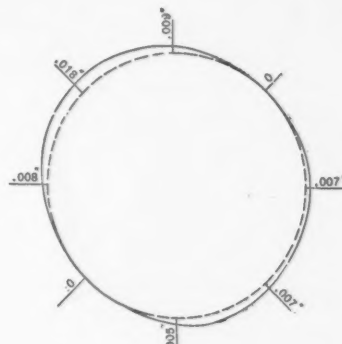


FIG. 3.

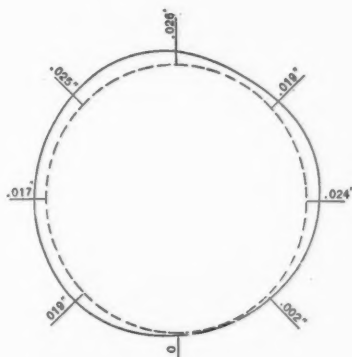


FIG. 4.

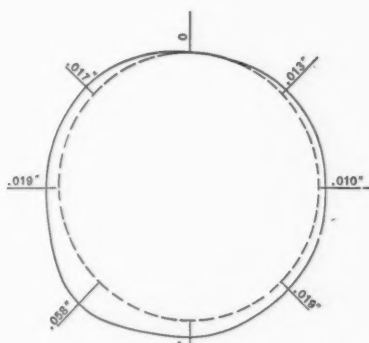


FIG. 5.

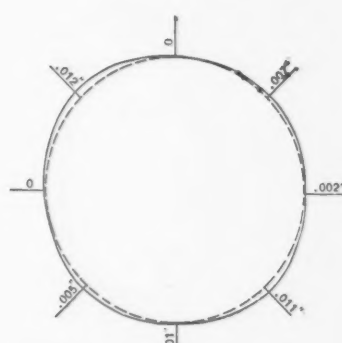


FIG. 6.

intendent of motive power, and H. E. Smith, engineer of tests, of the Lake Shore and Michigan Southern railroad, the actual status of the matter would still remain undefined.

Through these tests it has been possible to portray, as the diagram graphically indicates, the measured variation from the true circle which the tread of these wheels exhibited, six of the latter being tested as received new from an equal number of foundries.

In conducting this test the tread was divided into eight sections, each the same distance from the flange edge, and by the use of a specially constructed micrometer any variation in roundness became apparent. In the diagram the dotted circle within the full line represents the smallest radius obtained by these measurements, and is considered as the datum line. In plotting the diagram the actual variations from the datum line have been exaggerated in the ratio of 5 to 1, to more clearly portray the irregular contour of the tread, but in every case the figures given at the eight points on each wheel represent the actual measurement. It will be noted that wheel No. 5 exhibits a departure at one point of .058 in. from the true circle, and is extremely irregular in general outline. Wheel No. 1 is badly deformed as a whole, but particular attention is invited to its contour in the vicinity of point O.

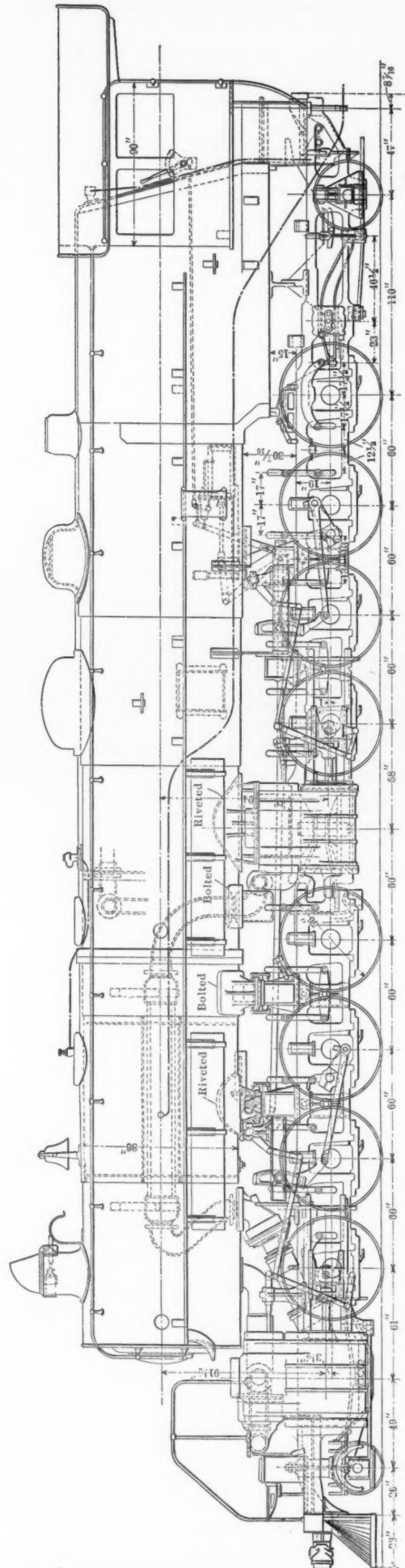
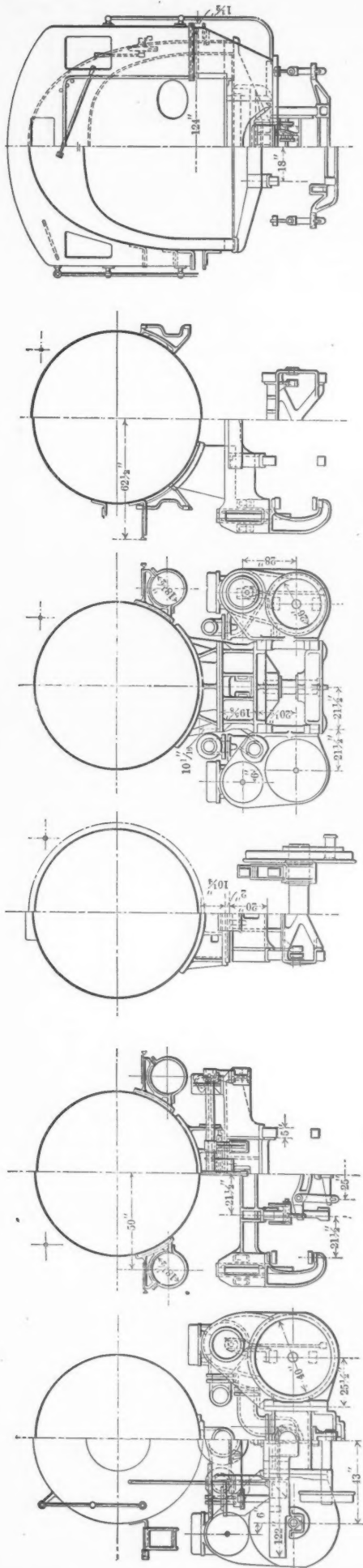
This depression, which is here so clearly indicated, may afford

of having the chilled crust uniformly "hugged" during its contraction. This being accomplished disposes of the chilled proposition and at the same time should insure truly round wheels, as irregularity in contour can readily be identified with variations in the depth of the chill.

### JOINT CAR INSPECTORS' ASSOCIATION.

The Chief Joint Car Inspectors and Foremen's Association held its annual meeting at Washington, D. C., last month. The election of officers for the ensuing year resulted as follows: Henry Boutet, Cincinnati, president (re-elected); F. W. Trapnell, Kansas City, vice-president (re-elected); Stephen Skidmore, Cincinnati, secretary and treasurer (re-elected); T. J. O'Donnell, of Buffalo; F. C. Shultz, of Chicago; William McMunn, of New York; L. J. Stark, of Columbus, and A. Berg, of Erie, executive committee.

THE GREAT WESTERN RAILWAY COMPANY of England, following the action of the Great Northern, Midland and Great Eastern Railway Companies, has abolished its second-class carriages and improved the third to equal the former second class.



GENERAL ELEVATION AND SECTIONS OF MALLETT TYPE LOCOMOTIVE FOR THE VIRGINIAN. BUILT FOR SERVICE ON A 2 PER CENT. GRADE. TOTAL WEIGHT 448,750 LBS. TRACTIVE EFFORT 97,200 LBS.

# Mallet Articulated Compound Locomotive of the 2-8-8-2 Type

A LOCOMOTIVE RECENTLY DELIVERED TO THE VIRGINIAN RAILWAY BY THE BALDWIN LOCOMOTIVE WORKS, BUILT UNDER A GUARANTEE TO HAUL 20 CARS WEIGHING 28 TONS EACH, TOGETHER WITH A CABOOSE, UP A 2.07 PER CENT. GRADE.

Exceeded in total weight by only one locomotive on our records, viz., the Santa Fe 2-8-8-2 type,\* locomotive, No. 600, recently built by the Baldwin Works for the Virginian, ranks among the largest and most powerful in the world. Because of the employment of trucks, however, the weight on drivers of this locomotive is exceeded by both the Erie 0-8-8-0 type† and the Delaware & Hudson 0-8-8-0 type,‡ built by the American Locomotive Company, which weigh 410,000 lbs., and 445,000 lbs., respectively, as compared with 405,400 for the Virginian. The Santa Fe engine, with 412,350 lbs. on drivers, also exceeds it in this respect.

In general, this locomotive follows the standard practice of the builders for this class of power and contains no features of importance that have not already been fully illustrated in these columns. It is in many ways a slightly enlarged example of the

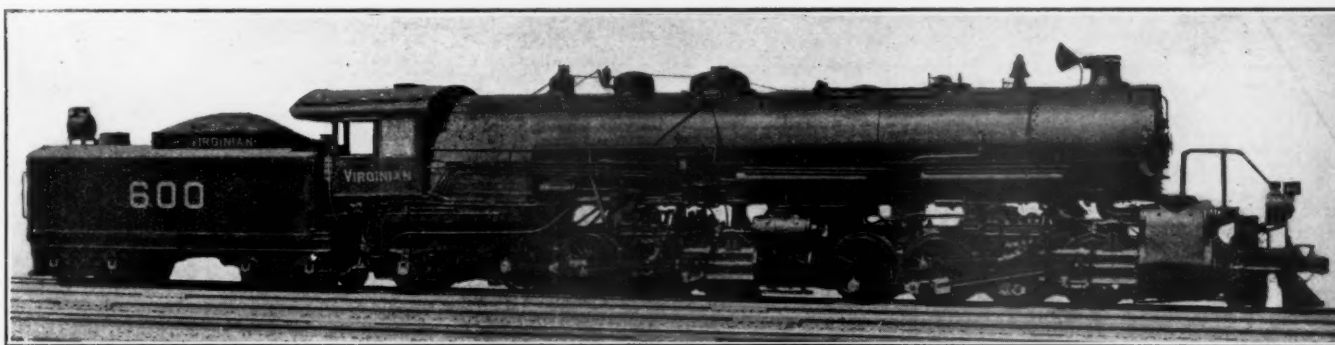
in shape and gives a grate area of 84 sq. ft., is employed. Flexible staybolts to the number of 440 are used in the throat, back head and side water legs of the fire box. The grates are arranged to rock in four sections, the dump grates being in the center of each side.

Cast steel frames 5 in. in width are used throughout. The trailing truck is of the Hodges type, a duplicate of the ones applied to the 2-8-2 type locomotives\* in service on the same road.

The general dimensions, weights and ratios are given in the following table:

## GENERAL DATA.

Gauge .....	4 ft. 8½ in.
Service .....	Freight
Fuel .....	Bit. Coal
Tractive effort .....	97,200 lbs.
Weight in working order .....	448,750 lbs.



2-8-8-2 TYPE LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE VIRGINIAN RAILROAD.

two locomotives built last year by the same works for the Southern Pacific Co., which were illustrated on page 181 of the May, 1909, issue of this journal, the details being shown on page 367 of the September issue of the same year.

The evaporative section of the boiler contains 401-2¼ in. flues 21 ft. in length, which terminate in a combustion chamber ahead of which there is a feed water heater having 401-2¼ in. flues 7 ft. long. The boiler is separable as is now the standard practice of this company for locomotives of this kind, the joint coming at the middle of the combustion chamber. Instead of the high pressure steam pipe being carried outside of the boiler shell, the dome in this case is set in about its usual location for a consolidation locomotive and contains a throttle and dry pipe of the usual type, the latter terminating in a T head in the combustion chamber, from which the steam is carried in two steam pipes to a cast iron saddle secured on the under side of the combustion chamber, which has cored in it passages for both the high pressure steam and the exhaust from the high pressure cylinders. Short pipe connections continue these passages to the cylinders.

A reheater of the same type employed on the C. B. & Q. locomotive§ consisting of two large cast steel headers connected by 31-2 in. tubes, all being contained in a large 21 in. tube through the center of the feed water heater, is connected to the exhaust passage in the casting just mentioned by an elbow pipe of large radius. In the front end a pipe, shaped as shown, carries the steam to the bottom of the smoke box, where a flexible pipe continues the passage to the low pressure cylinders. These cylinders are bolted to a large steel casting constituting part of the front frame system in the same manner employed in the other design mentioned.

A radial stayed firebox, which approximates the Wooten type

Weight on drivers .....	405,400 lbs.
Weight on leading truck .....	21,000 lbs.
Weight on trailing truck .....	22,350 lbs.
Weight of engine and tender in working order .....	625,000 lbs.
Wheel base, rigid .....	15 ft.
Wheel base, total .....	58 ft. 2 in.
Wheel base, engine and tender .....	89 ft. 2½ in.

## RATIOS.

Weight on drivers ÷ tractive effort .....	4.16
Total weight ÷ tractive effort .....	4.60
Tractive effort × diam. drivers ÷ heating surface* .....	785.00
Total heating surface* ÷ grate area .....	82.50
Weight on drivers ÷ total heating surface* .....	58.40
Total weight ÷ total heating surface* .....	64.70
Volume equiv. simple cylinders, cu. ft. ....	20.30
Total heating surface* ÷ vol. cylinders .....	236.00
Grate area ÷ vol. cylinders .....	2.87

## CYLINDERS.

Kind .....	Compound
Diameter and stroke .....	26 & 40 x 32 in.

## VALVES.

Kind .....	Piston
Diameter .....	15 in.

## WHEELS.

Driving, diameter over tires .....	56 in.
Driving, thickness of tires .....	3½ in.
Driving journals, main, diameter and length .....	11 x 12 in.
Driving journals, others, diameter and length .....	10½ x 12 in.
Front truck wheels, diameter .....	28 in.
Front truck, journals .....	5½ x 10 in.
Trailing truck wheels, diameter .....	36 in.
Trailing truck, journals .....	6 x 11 in.

## BOILER.

Style .....	Straight
Working pressure .....	210 lbs.
Outside diameter of first ring .....	86 in.
Firebox, length and width .....	126 1/16 x 96 in.
Firebox plates, thickness .....	¾ & 9/16 in.
Firebox, water space .....	F. 6 in., S. & B. 5 in.
Tubes, number and outside diameter .....	401—2¼ in.
Tubes, length .....	21 ft.
Tubes, feedwater heater .....	401—2¼ in. 7 ft. long
Heating surface, tubes .....	4,934 sq. ft.
Heating surface, firebox .....	298 sq. ft.
Heating surface, total boiler .....	5,232 sq. ft.
Feedwater heater heating surface .....	1,694 sq. ft.
Grate area .....	84 sq. ft.

## TENDER.

Wheels, diameter .....	33 in.
Journals, diameter and length .....	5½ x 10 in.
Water capacity .....	9,500 gals.
Coal capacity .....	16 tons
*Includes feed water heating surface.	

\* See AMERICAN ENGINEER, June, 1909, page 225.

\* See AMERICAN ENGINEER, December, 1909, page 477.

† See AMERICAN ENGINEER, September, 1907, page 338.

‡ See AMERICAN ENGINEER, June, 1910, page 207.

§ See AMERICAN ENGINEER, May, 1910, page 171.

# The Pioneer in Introducing General Piece-Work

A REVIEW OF THE BALTIMORE & OHIO'S EXPERIMENT OF TWO DECADES PAST, IN WHICH EVERY OPERATION IN THE MECHANICAL DEPARTMENT OF THE RAILROAD HAD ITS PRICE.

Twenty years ago, or, to be exact, on November 15, 1890, an important conference was called at the Mt. Clare shops of the Baltimore and Ohio Railroad, in Baltimore, Md. In view of the importance which attaches at the present to piece and bonus work, it is interesting to recall that the discussion which the above gathering implied had for its end the inauguration of a piece-work system on a scheme so comprehensive as to be practically undreamed of in a period where compensation for labor in other than the straight day basis was universally viewed with distrust.

It was proposed in this meeting that every operation connected with the building and up-keep of cars and locomotives should

46.

## VALVE SEATS. Facing---All classes.

Disconnecting tallow pipe-----	.02
Removing steam chest top casing-----	.02
Removing steam chest side casing-----	.02
Removing steam chest cover-----	.16
Removing steam chest studs, per stud-----	.01
Disconnecting valve stem from yoke-----	.02
Removing steam chest relief valve (if necessary)-----	.02
Removing steam chest-----	.05
Facing seat and spotting valve, by hand-----	1.25
Facing seat and spotting valve, by rotary planer-----	1.00
Applying steam chest-----	.03
Applying steam chest studs, per stud-----	.01
Applying side casing-----	.02
Applying steam chest cover-----	.16
Applying top casing-----	.02
Connecting tallow pipe-----	.02
Connecting valve stem to yoke-----	.02
Applying steam chest relief valve (if removed)-----	.02

In instances as above where seats are faced opportunity should be taken to secure new port marks on valve stem-----25

It is preferable in removing the steam chest to lift the chest and valve yoke off the valve, allowing the latter to remain on the seat, this to avoid breaking the valve stem metallic packing. In construction which does not permit this, removing packing and valve yoke-----10  
Applying metallic packing and valve yoke-----10

## VALVE SETTING. All classes.

It is presumed that the port marks are on the stems; if not the local piece-work inspector will allow from the above operations in connection with facing valve seats payment for the parts necessarily removed and re-applied; these would be, disconnecting and connecting tallow pipe; removing and applying top casing, and removing and applying top of steam chest, or cover. The valve setting operations then follow as below: the locomotive being moved under its own steam.

Getting centres, per centre-----	.18
Tramming valve stems, per side-----	.15
Changing eccentric rods having liners in foot, each-----	.16
Removing and re-applying non-adjustable rods, each operation-----	.20
Changing lead, per eccentric-----	.30

These are the common operations in roundhouse valve setting. If necessary to go further into it be governed by erecting shop book prices for removing and applying reverse lever, quadrant, reach rod, lifting shaft, link hangers, links, rockers, rocker boxes, and valve stems.

FIG. I

be paid for on a price per job, no matter how insignificant or how elaborate the work might be. It was a daring conception in those days, when the day or the hourly rate absolutely ruled, because it meant the retirement of a plan of pay for labor which for generations had been handed from father to son, and furthermore it was in connection with the oldest railroad in America: one on which drastic innovations were practically unknown, and one which was ever characterized by adherents to time-honored standards.

Those who attended were A. J. Cromwell and William Harrison, respectively superintendent of motive power east and west of the Ohio River; S. B. Crawford, master mechanic of the Mt. Clare shops; I. N. Kalbaugh, master mechanic of the Pittsburg shops; E. L. Weisgarber, from Newark, O., and

many others who have since helped to make B. & O. history. It was the aim of these men, through instructions from Charles F. Mayer, then president, to evolve a scheme of piece work which would absolutely preclude day or hourly work, in other words, a scheme so complete in its detail that if a man picked some broken cylinder packing rings from the roundhouse floor and threw them in the scrap bin, a price would be set on the operation. This may seem preposterous almost, but it is nevertheless the refinement in which it was intended that it should be worked.

Before proceeding with a review of what was adopted, and what was accomplished, it may be well to glance at that period from a labor standpoint, in order to determine whether acquiescence or opposition was the attitude of the rank and file: those naturally most affected through the innovation. It may as well be said, having voluntarily espoused this consideration, that in those days organized labor, so far as applied to shopmen, was an inconsiderable reckoning. While it is very true that certain organizations existed, there was no unity of purpose, no agreements signed by the party of the first and that of the second part, and a full realization on the part of labor that it would come out second best in any protracted struggle effectually forbade any resistance to a mandate of the railroad company.

Had organized labor existed at the time in its present strength it is quite likely that it would have resisted and defeated piece-work. As it was, there was a violent opposition to the new plan in evidence, and although conference succeeded conference, it did not get under way in the elaborate form proposed until 1893, when times were so bad that some shops worked only eight hours per day, three days a week.

The Baltimore and Ohio in those times was not the splendidly developed and smooth working property of to-day, but it was still a road of considerable importance, and properly ranked as one of the great trunk lines. It maintained large locomotive and car repair shops at Baltimore, Md.; Martinsburg, W. Va., and also at Keyser, Piedmont and Grafton in the latter state; Pittsburgh, Pa.; Newark, O., and Garrett, Ind. In addition to these principal division points there was a large number of small outlying terminals scattered over the road from Chicago to Philadelphia. The system generally was not in good condition; in fact, even in 1893, the handwriting on the wall which pointed to the receivership which followed in 1896 was plainly visible. It is believed that the general piece-work system was the last desperate stand to forestall the inevitable.

In brief, the plan evolved after long deliberation was that of straight piece-work; that is, a price for each and every job, and with no guarantee of a man's pay at his regular day rate. The average pay for a machinist on the Baltimore and Ohio in 1893 was \$2 per day, or probably the average was slightly lower, say \$1.95; boilermakers, about \$2; carpenters, painters and pipe fitters, \$1.75, rates but little more than half what is now paid for similar trades.

It was the scope of the scheme to pay only what was earned; for instance, if a man was unfortunate, and only made a dollar, he was a dollar in the hole on his day's pay; if things worked well and he earned three dollars, he was one ahead, which might help to make up for a bad day to-morrow. There was bitter dissatisfaction expressed over this plan, because on some of the jobs it was impossible to come out, and it should be remembered, in connection with roundhouse work, that every mechanic had a helper at \$1.25, thus forcing the mechanic to earn \$3.25 to quit even on the day.

In the machine shops, where the work was continuous, it worked well enough, and in the erecting shop, when the work

was furnished with reasonable promptness, there was little complaint, but in the roundhouse, where work is impossible to foresee, it became a distressing proposition. A mechanic with his

OFFICE OF THE GEN'L SUPT. OF MOTIVE POWER.

Mt. Clare May 27 1894

Mr. John Brown M. M.  
Garrett Ind.

We note that the price paid in your shops for removing old and applying driving spring, class I-6 Eng. is \$1.50 while the price paid at Philadelphia for the same operation is .75. Please advise what difference in conditions exists in your territory making it necessary to warrant an increase of .75 over the price paid in Phila. In your reply use ruled space below, which do not detach from this form.

Yours truly,

W. A. Smith.

General Piece Work Inspector.

Reply to above:

Garrett Ind. June 2, 1894

Before price work was started the day rate for machinists was higher west of the Ohio river than in the east, therefore this was the lowest price price at which we could consistently arrive and be fair to the men.

John Brown M. M.

FIG. 2.

helper might be out of a job for two hours, thus losing between them 65 cents, because this system of piece work did not make provision to pay men for waiting on work. If a main rod brass had to go to the machine shop to be rebored, there was nothing for the roundhouse mechanic and his helper to do but stand around at their own expense until it was ready, unless the harassed foreman could find them a little job on some other engine in the meantime. Every conceivable and imaginable job was covered in the piece-work schedules, the preparation of which required over two years, and the master mechanics had no authority whatever to revert to day work, no matter what difficulties the operation might present, or how much money the man doing it was losing. It was to be piece-work absolutely, from one end of the railroad to the other.

During the two years mentioned all of the various operations in the different shops were prepared on standard typewritten sheets, and from these blue print books were made, with a white marginal line to the right for the insertion of the price to be paid. A set of these books, each covering its particular department, was then forwarded to the various master mechanics, who were privileged to set their own price against the operation, presumably without knowledge of what was being paid on any of the other divisions. Fig. 1 is a reproduction of one sheet from the running repair book, and is interesting as an illustration of the detail followed out, and incidentally the money paid in those days. It, however, should be recalled that, in 1893, 18 x 24 in. engines ruled, and the parts were light and easily handled.

After setting the prices each master mechanic returned his set of books to the General Piece Work Inspector at the Mt. Clare shops in Baltimore, where they were entered on large charts for comparison. It is proper to explain at this point that no prices were set by the officials in Baltimore. This was a matter for the division master mechanics to handle exclusively, but the value of a comparison between all divisions of the prices set on a single operation is obvious.

In the majority of cases there was a striking uniformity in the prices assigned, while in others great discrepancies were in

evidence, of which the following may serve as an example. An eastern shop of the system, which we will call Philadelphia, entered in its running repair book a price of 75 cents for removing a broken spring and applying another to a certain class of engine, while a western shop, called Garrett, returned a price of \$1.50 for the same operation. This was an instance of extreme variation in rates, and all such were handled by the general piece work inspector on forms illustrated in Figs. 2 and 3, which are largely self-explanatory.

That great good was achieved through the proper use of these forms is clearly indicated by an analysis of the forms. In this case a competent general piece work inspector would immediately familiarize himself with the operation in Philadelphia, through which the price was so greatly reduced in connection with the application of this spring, and would hasten to communicate this particular method to the remaining shops on the system, with the ensuing good result that the price would inevitably become harmonized throughout the length of the railroad.

To further explain, it will be seen that the master mechanic at Garrett was not in possession of the most practical method to remove the spring in question. He took refuge behind the fact that labor is more highly compensated west of the Ohio River than east of it; as it also applies to west and east of the Mississippi, but the use of the two forms as herein illustrated brought out the truth, that the master mechanic in Philadelphia had found a way to pull this spring out without dismantling foreign parts of the locomotive, and in consequence could assign a greatly reduced price and still allow the mechanic to make a small profit.

This is only an illustration of what prevailed in many other roundhouse operations, and shows clearly that the various shops of the road were in absolute ignorance of the methods of their neighbors. So, even if this system of piece-work failed, or was eventually abandoned, it certainly served a useful purpose in standardizing shop methods.

Despite its crudities, the system endured for at least three

OFFICE OF THE GEN'L SUPT. OF MOTIVE POWER.

Mt. Clare May 27 1894

Mr. G. Jones M. M.  
Philadelphia Pa.

We note that the price paid in your shops for removing old and applying driving spring class I-6 Eng. is .75 while the price paid at Garrett for the same operation is \$1.50. Please advise how you are able to perform this operation at a rate so much lower than that paid at Garrett which in this instance is .75. In your reply use ruled space below, which do not detach from this form.

Yours truly,

W. A. Smith.

General Piece Work Inspector.

Reply to above:

Philadelphia Pa. June 1894

When these engines first came here we discovered a way to remove and apply these springs without taking down a portion of the brack-rigging which I understand is being done elsewhere, hence our lower prices.

G. Jones M. M.

FIG. 3.

years. Without a doubt the railroad company had the best of the bargain, because a careful analysis of a single machinist's time for two years under this piece work, compared with the same period under day work, showed an increase in the number

of individual operations performed of 65 per cent., with a grand average of an increase in pay of but 5 per cent. The prices were so low that even with the minimum day rate prevailing at the period it required vigorous effort to come out even on the day. If a machinist's or a boilermaker's pay averaged \$57 per month on day work, and this represents about the average for the times, it seldom rose above \$65 on the piece work basis, and no comment need be made on the superior effort set forth under the latter plan.

Before dismissing this matter it is of interest to recall that the plan did embody a successful application of piece-work to locomotive running repairs; that is, a more successful application than is evinced in even these latter days, in which the round-house end of it has always proved the snag in straight piece-work. Maybe after all it worked, because from what was said at the beginning, the railroad had all the best of it in the labor situation. There was no concerted effort to resist it, because the times were hard; there was no organization, and in the end the men would have been badly worsted.

In the principal divisional points no hardship was entailed on anyone, as the work was coming all the time, and very few

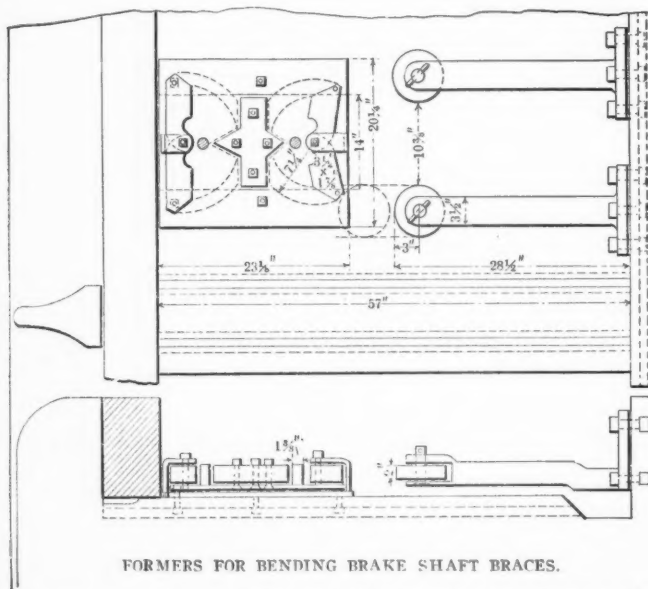
instances can be recalled where a man quit the month any worse off than if the day rate had been followed throughout, but in the smaller places the scheme was impracticable, and should never have been installed. At Wilmington, Del., for instance, which at that time was probably run on a smaller scale than any outlying point on the Baltimore and Ohio, the wages of some car repairers were pathetic. The figures are not at hand, but if memory serves, a repair man at \$1.40 daily rate was fortunate to draw \$1.

Nevertheless, the plan was assiduously pushed until the crash came in February, 1896, when the road passed into the hands of John K. Cowan and Oscar G. Murray, receivers. G. B. Hazlehurst was succeeded shortly after that time by J. Harvey Middleton, as general superintendent of motive power, and one of the first moves of the new mechanical department management was to practically abolish the piece-work system. Whatever piece-work conducted after that was left entirely to the discretion of the various master mechanics. The shop men returned to the day rates which they held previous to 1893 and 1894, and quite a period elapsed before any further consideration was given to the subject.

### BENDING BRAKE SHAFT BRACES

Brake shaft braces come within the class of work which is well suited for manufacture with a bulldozer, and at the Readville shops of the New York, New Haven & Hartford Railroad, a set of dies have been evolved for performing that operation, so that these braces are turned out at the rate of about 100 per hour, two men being required.

The dies and their arrangement, as well as the brace before and after bending, are shown in the illustration. Dies for two different sizes of braces are included on the same base, and



either one can be used. They consist, as will be seen, of a pin of the right diameter, back of which are hinged two swinging formers, which close down upon a stationary form in such a way as to force the  $\frac{3}{8}$  by  $1\frac{1}{2}$  inch bar around the pin, and in one operation form it to the proper shape. The swinging dies are forced inward by rollers carried by extending arms located the proper distance apart and secured to the movable head of the bulldozer.

After the braces have been formed, the holes are punched cold in an ordinary punch, a gauge being used which eliminates the necessity for any marking.

roads of Mexico during the last six months as follows: "The additions to the railways under federal jurisdiction since April last have been 148 miles, and those railways now aggregate 12,225 miles, so that the 3,000 miles of railways subject to the jurisdiction of the state be added, we obtain a total of 15,225 miles as the present length of railways of the Republic.

**PROPOSED IMPROVEMENTS ON THE BOSTON AND MAINE.**—President Charles S. Mellen, of the New York, New Haven and Hartford Railroad, and lately elected president of the Boston and Maine, will take the full duties of the presidency in solving the important problems in improving the latter system. An important branch of those problems is the relaying of a large part of the system with new rails, the purchase of new equipment, and particularly of heavier locomotives for service upon the northern part of the system, and the Fitchburg line. Another important improvement proposed is the electrification of service through the Hoosac tunnel. This will require several years to complete. The \$10,000,000 lately voted by the directors will be used for these improvements, and is in addition to a large sum expended during the past year.

**STEAM RAILROAD ELECTRIFICATION IN GERMANY.**—The experiments which have been carried on in Germany during the last three years with a view to replacing steam by electric energy on the lines of railway have been so conclusive that it has been resolved to introduce the new method of traction at an early date on several lines of railway. Before the end of the present year the work of electrifying the railway running between Bitterfeld and Dessau, the first section of the railway connecting Madgeburg, Leipzig and Halle, will be finished, and during 1911 the work will be begun on the line connecting Dittersbach and Lauban in Silesia. This latter line runs through very mountainous regions.

**ALTERNATING CURRENT FOR HEAVY TRACTION ABROAD.**—Glancing over a list of the twelve or fifteen three-phase roads and the twenty-five or thirty single-phase roads in Europe, I find that there was much that I did not see, but what I did see was impressive of present progress and of the large plans which are being made for the future. Practically all interest seems to be directed toward alternating-current development for heavy traction, either single-phase or three-phase, and at a low frequency, approximately fifteen cycles, this being accepted as the standard by several governments.—Chas. F. Scott in the *Electric Journal*, October.

**MILEAGE OF MEXICAN RAILWAYS.**—In a message to the Mexican Congress, President Diaz reviews the progress of the rail-

# The Acetylene Welding Torch

A DISCUSSION ON THE MIXING OF GASES IN THE TIP OF A WELDING TORCH, HOW THE HIGH TEMPERATURE IS MAINTAINED AND WHY IT IS NECESSARY. HOW THE DANGER OF EXPLOSION HAS BEEN ELIMINATED AND THE METHOD OF USING THE TORCH ARE ALSO CONSIDERED.

J. F. SPRINGER.

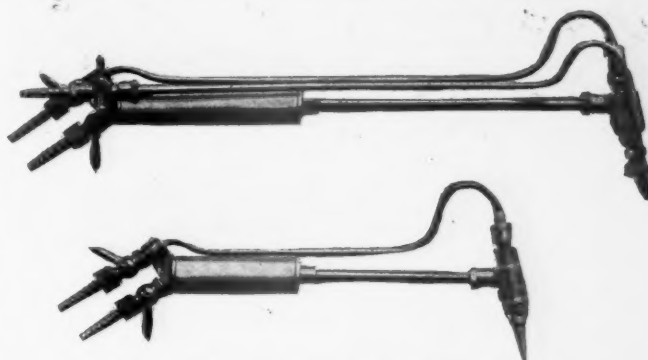
While there are a number of methods for obtaining high temperatures, the most familiar is probably that of combustion. Ordinary combustion consists in the chemical union of oxygen with some other substance, and by this process heat is evolved. Thus, when coke combines with oxygen to form the poisonous gas, carbon monoxide (CO), a considerable amount of heat is set free. If hydrogen gas is burnt, that is, combined with oxygen, we get a large amount of heat. Heat can also be obtained by breaking up, or exploding, certain compound substances. Thus, when nitroglycerin is exploded, heat is evolved. The former method is in use everywhere, but the latter is practically unknown. There is a third source of heat; viz., the electric current. When a strong current is made to pass through a wire whose diameter is such that there is inadequate provision for conduction, then we get heat from the resistance of the wire, and this is what takes place in the incandescent electric bulb.

In the oxy-acetylene torch heat is secured through a combination of the first two methods. First, there is a detonation of the acetylene as it emerges from the nozzle; and, second, by the carbon gas resulting from this breaking up of the acetylene combines with the oxygen flowing out of the tip. About one-half of the resulting heat is supplied by each chemical action, but this double source of heat is not sufficient to account for the very high temperature obtained. It is said that the oxy-acetylene torch of the Davis-Bournonville Co., 90 West Street, New York City, is capable of producing a temperature of 6000° F. or more. It so happens that about twice as much heat is produced in the outer, or enveloping flame, as in the inner, or working, flame. The advantage of the inner flame lies in the concentration of heat. In an ordinary torch this little inner flame will be, perhaps, half an inch long, and have a diameter of about one-sixth of an inch. Here is concentrated about one-third of the total heat produced by the detonation and total combustion of the acetylene.

It is of interest to know why the little inner flame which does the work is so bright. Apparently, the reason is that here the carbon is flowing along uncombined with anything, but at a very high temperature. It has just parted from the hydrogen, with which it was combined when in the acetylene, and flowing along at a high temperature, it shines with a bright white light.

Surrounding the little working flame is a large enveloping

ice in protecting the little working flame from loss of its heat through radiation and the like, and, further, there is probably some free oxygen coming through the little flame. The reason for this statement is that it has been found necessary to supply more oxygen in mixing than is really required to burn the acetylene to carbon monoxide, which necessity is probably due to difficulty of getting perfect mixture, the remedy being to supply an excess. The oxygen coming through the little flame would,



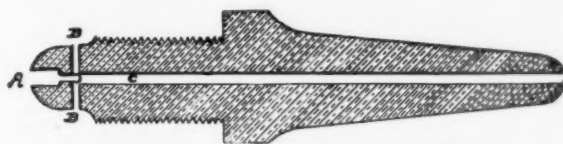
TWO SIZES AND DESIGNS OF WELDING TORCHES

if not consumed in some way, oxidize the work, which might prove serious and even prohibitive. It is, no doubt, the enveloping flame which takes care of this surplus, its hydrogen and carbon monoxide sucking up the oxygen. The outer flame is, therefore, to be considered on the whole as a very valuable adjunct.

Curiosity may be entertained why it should seem important to secure temperatures of 5000° and 6000° F., but it should be remembered that this temperature is that of the flame and not of the work. It would be useless to heat the metals to any such temperature. In explanation it may be said that the oxy-acetylene torch is used in the open air to affect the heating of a small quantity of metal. The bulk of the work acts as a dissipater of heat. Consequently, because of dissipation into the atmosphere and through the body of the work, it is absolutely necessary to furnish a temperature far in excess of that required to melt the metal itself.

The nozzle used by the company mentioned is simple in form and is shown in section in one of the illustrations. Oxygen comes in along the axis under pressure, and is made to pass through a very small orifice (A). Emerging from this it still has nearly the whole length of the nozzle to traverse. However, just a little forward of the front side of the small orifice, there are several others (B) arranged in the wall of the nozzle. These admit acetylene in radial streams, which is under less pressure than the oxygen. The two gases thus meet when moving in directions at right angles to each other, and in consequence a certain amount of mixing takes place at once. Further mixing occurs as the two gases move on through the length of the nozzle. This passageway has a smooth cylindrical wall, and its length provides opportunity to complete the mixing to a more or less perfect stage. It seems important that the mixing chamber should be a plain bore without turns or obstructions to effect intermingling; otherwise danger might perhaps arise in connection with the acetylene which is an explosive gas. In this tip, oxygen under high pressure drives acetylene under low pressure along a straight and smooth bore.

In that part of the torch back of the tip, the acetylene is made



SECTION OF THE WELDING TIP

flame. This is hot, but not hot in comparison with the smaller one. Here, no doubt, the poisonous carbon monoxide is burnt to the dioxide. The danger of carbon dioxide to life is because it may, under favorable circumstances, prevent sufficient oxygen reaching the lungs. It smothers but does not poison, so the large flame may be regarded as advantageous, because it converts a deleterious gas into a non-deleterious one. The hydrogen that comes through from the little flame burns to water vapor here in the large one. In fact, the combustions going on produce a large supply of heat, though not a high temperature, which is accounted for by the fact that the heat is scattered over so much space. The large amount of heat, however, is of serv-

to pass through a packing of asbestos and mineral wool. This protection is similar to that afforded by the gauze of the miner's lamp. The acetylene can pass, but not the flame. But, even if a flare-back should pass this packing, there is another and very reliable safeguard. The tube which leads back to the acetylene generator-and-reservoir passes into and out of a water



BROKEN CYLINDER ON A VAUCLAIN COMPOUND LOCOMOTIVE. AN ATTEMPT WAS MADE TO REPAIR IT WITH THERMIT, BUT OWING TO THE MOULD SLIPPING THE PIECE BROKEN OUT WAS RUINED. A NEW PIECE TO FIT WAS THEN CAST AND WELDED INTO PLACE BY THE ACETYLENE PROCESS AS IS SHOWN BELOW. THE LOCOMOTIVE IS NOW IN SERVICE WITH NO SIGN OF A LEAK OR ANY WEAKNESS.

tank. Here it is interrupted, so that communication between the two portions of the tube is only secured by passage through the water. A flare-back would thus be extinguished before it could reach the acetylene supply. It would seem very unlikely, however, that a flare-back should occur, when the manner is recalled of the way the two gases enter the tip.

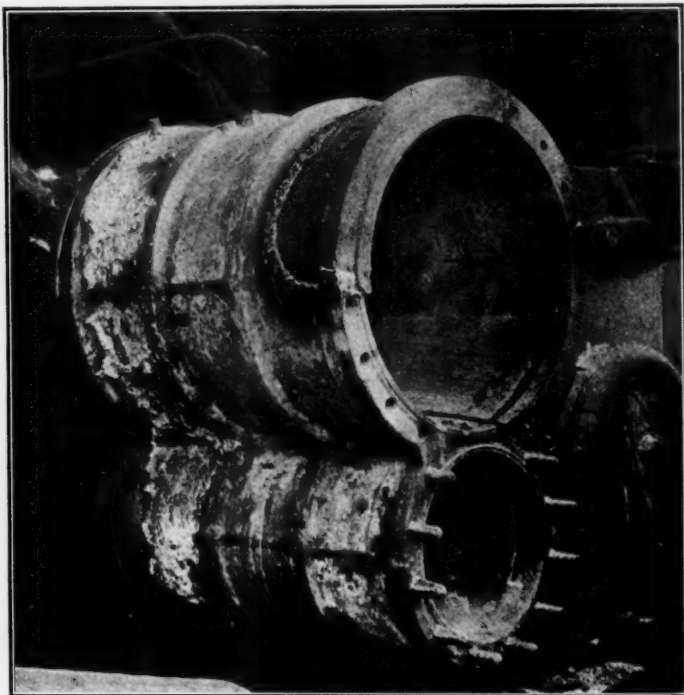
The oxygen comes in along the axis and forms the main current, because it comes in under higher pressure, and because its direction of flow is not changed in the tip. The acetylene joins this current coming in from the sides. It is under a less pressure and has its direction changed; and, further, the oxygen strikes it from behind, as it were. Apparently, the only way a flare-back could occur is for the oxygen to find its way in some manner back through the acetylene supply pipe. By avoiding the presence of any obstruction to the flow of the oxygen through the tip, all danger of this would seem to be eliminated. Perhaps, however, it would be best for workmen to avoid allowing the end of the tip to get clogged or otherwise obstructed by the work. But even so, there are two safeguards back of the tip: the packing and the water tank.

The oxy-acetylene torch is easily handled like any other tool. The great temperature of the little inner flame is employed with striking results in effecting what are called "welds." That this term is scarcely a proper one will readily be understood when the true character of the process is understood. We will suppose that we wish to join the edges of two sheets of  $\frac{1}{2}$ -in. steel. Each edge is first beveled off at an angle of  $45^\circ$ , so that when the two are placed together we have a groove with an angle of  $90^\circ$ . The operator begins the use of the torch to heat

the sides of the groove, particularly at the bottom. As the metal softens, matters are so managed as to fill in the bottom with metal from the work, and then to fill in the groove higher up by melting new metal from a rod. Attachment to the groove sides is accomplished by heating them to a more or less softened condition. In all this work the little flame is the principal agent. The filling in is continued until the whole groove is filled, and if it is desired to make the seam especially strong, the new metal can be added until a slight ridge is formed, which can be rounded off to present a neat appearance. The foregoing is the general method, and it will be seen at once that it is quite different from that employed by the blacksmith, as the metal is actually melted. At the junction of the new metal with the old the employment, at times, of a hammer or similar instrument may facilitate the union with the old. Perhaps the name *fusion welding* best covers the operation.

As already suggested, the work itself tends to carry off heat. This, of course, increases the duty of the torch. If the metal is in the form of quite thin sheets, then the torch can be depended upon to accomplish the union unaided. The loss of heat becomes so enormous, however, in cases where the metal is thick that oftentimes it is economical or necessary to assist the torch. For example, it is quite possible to unite metal where the thickness is 5 or 6 inches. The groove is prepared as usual, but in order to prevent excessive losses of heat from the little flame an additional source of heat is provided. In some cases it may be possible to maintain a charcoal fire beneath the locality of the groove. In others, the adjacent metal may be heated by any convenient means, as in a furnace, and the welding effected while the work is still hot, or a flame such as that provided by the Rockwell torch may be used in conjunction. In any case, the idea is to supply from another source a portion of the heat otherwise carried off by radiation and conduction.

A little consideration will show one that the metal involved, both new and old, is subject to very considerable expansion and contraction. Mild steel has a co-efficient of linear expansion of about 0.000066 for  $1^\circ$  F. For, say  $2400^\circ$ , we should have 0.01584. If at the top of the groove the new metal has a width of 5 inches, the shrinkage from a molten, or nearly molten, condition would be considerable. The same thing goes on propor-



THE CYLINDER AFTER NEW PIECE WAS WELDED INTO PLACE

tionately in smaller welds, and it will be seen that the operator will have something more to do than merely fill up the groove and see that a satisfactory union between old and new metal takes place. He must manage the cooling to prevent contraction cracks, and here is where skill and experience are required.

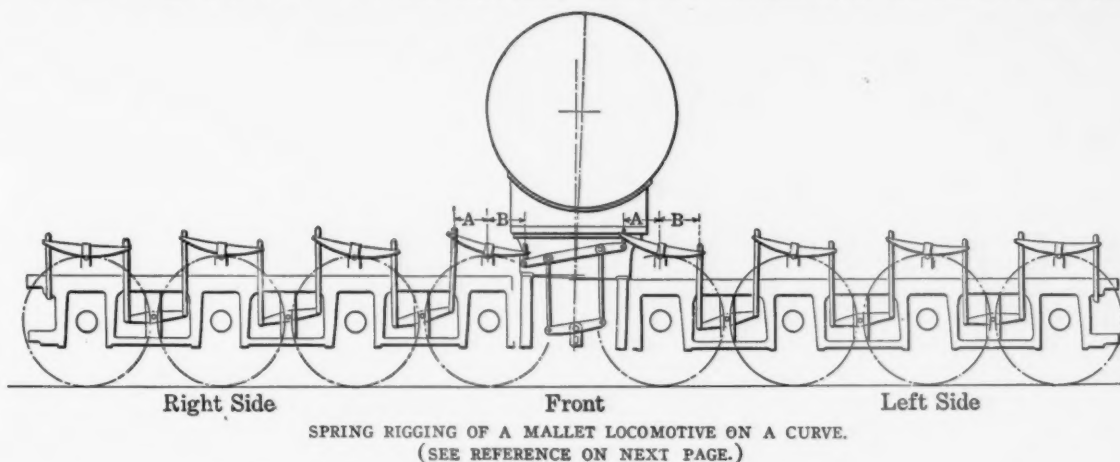
Welding by means of the oxy-acetylene flame is a matter of only a few years, and those interested in it have by no means found out all there is to know, but perseverance and intelligence have steadily advanced knowledge so that today the successful application of the process has been made to numberless lines of work. In many of these, the methods have been more or less standardized, so that definite instructions can be given, and new work is constantly being included within the bounds of well established practice.

The great temperature of the little flame is being utilized to perform an office quite different from that of welding. The torch is often used as a "putting on" tool. For example, take the case of a large gear wheel in which a tooth has been broken. To get a new gear may involve great delay—shutting down of considerable machinery, and large expense for the wheel itself—but with the oxy-acetylene torch new metal may be added and a blank tooth built up on the root of the old. This is accomplished in the same way as in ordinary "fusion welding." There, new metal is filled into the groove, and similarly, the broken tooth can be built up, layer by layer, until a mass of such form and size has been added to enable the finishing-machine operations to produce a perfect tooth. The same procedure is applicable to cases where a lug or other protuberance has been broken off from a casting. It makes no difference whether the casting be new or old, or whether the protuberance has been broken off or omitted through oversight in casting. A little consideration will show that this building up process is extremely important.

of the same material as the body, and rolled or forged steel may be hardened. The new material may often be made similar to the old not merely in chemical composition, but in its condition. This is accomplished by hammering as the new metal is added.

Indeed, parts of dissimilar metal may be united; or a part of one material may be built up on a body of a different character, which is important. In this way a bronze part may be joined to a steel part, the whole becoming a unit. High carbon steel can be united to mild steel, thus permitting the hardening of one. An example in point is where a manufacturing concern makes a pipe out of sheet steel and then adds flanges of cast steel. These are joined to the pipe by oxy-acetylene welding. It may be added that the longitudinal seam is also made by the same process. Such pipes (5 to 7 inches in diameter) are put under a pressure test of 1,000 pounds to the square inch. It is said that the test is ordinarily successful when first applied.

The chief expense in oxy-acetylene welding, when the outfit has once been obtained, is for the oxygen. The expense per cubic foot of oxygen may be taken at three cents; per cubic foot of acetylene, at one cent. Now 28 per cent. more oxygen by bulk is supplied than acetylene, so that the oxygen corresponding to one cubic foot of acetylene will cost \$0.0384, making the total cost of both gases \$0.0484. To make a 100-foot "weld" of 1/16-in. sheet steel, 5.6 cubic feet of acetylene will be required. The expense for gas will therefore be \$0.0027 per foot, and it will take about two hours for the operator to weld



Cavities may be filled up in the same way and a blow-hole, crack or similar defect may be very thoroughly eliminated. For example, the case of a 4500-pound brass casting may be cited, which, upon examination, was found to contain certain cracks necessitating that the whole be scrapped, if not corrected, but the oxy-acetylene torch successfully reclaimed it from the scrap heap. In another case, a good-sized casting was to form part of air compression machinery, and extensive machine operations had to be carried out. When an amount, said to be \$300 worth, had been done, the discovery was made that a blow hole communicated with the air chamber. Here was a case where the defect would have resulted in considerable loss. But here also the new process was equal to the requirements of the occasion.

The oxy-acetylene procedure is largely indifferent to what the particular metal is. If the material is cast iron the torch will build up new parts, fill in cavities, or unite one piece to another, and the same may be said of most, if not all, of the common metals. The great temperature available secures such molten and plastic conditions that new metal can be added, and new and old united. No especial welding quality is needed. In the old days, only certain materials could be welded; and the possibilities of soldering and brazing were very limited. With the oxy-acetylene torch the new metal which is added may be precisely the same as the old. Parts of cast iron can be united by the use of cast iron in the seam. The cavities in a casting of brass or other material can usually be filled in with the same metal. The parts added by the building up procedure may be

100 feet. If his time is worth 30 cents per hour, the total expense for gas and labor will be \$0.0087 per foot. If the sheets are one-half inch thick, then the cost will increase to about 37 cents per foot. It is probable, however, that by perfecting means of re-heating, the cost of welding the thick sheets could be much reduced. In other words, a great deal of the necessary heating could probably be done much more cheaply by the use of fuels other than oxygen and acetylene.

## EQUALIZATION OF MALLET LOCOMOTIVES

TO THE EDITOR:

In reply to Mr. Fowler's criticism\* of my article on the "Equalization of Mallet Locomotives, which appeared on page 342 of your September number, I would like to quote from a paper read before the American Society of Mechanical Engineers in New York City, in December, 1908, by C. J. Mellin, as follows:

"On the front engine, all springs on each side are equalized together with a cross equalizer between the front springs. The rear engine is equalized in the same manner, except that the cross equalizer is omitted. This makes a three-point suspension of the whole engine and prevents any excessive local stresses of a diagonal nature on an uneven road; as the front engine accommodates itself very freely to the rear engine and approximately divides the angularity between the inclination of the axles. The

\* See AMERICAN ENGINEER, October, 1910, page 402.

wheels then follow the rail comparatively freely and easily on the twisting parts, at the rising of the outer rail, on entering and leaving curves, as well as on any other unevenness of the road."

It is self-evident that the tops of the rails at ends of curves form a warped surface and that the driving springs will have to take care of the difference between this warped surface and a plane, unless the front engine is equalized across. The point which I intended to make in my article was that this difference was not enough to cause any excessive stresses and that equalizing the springs on both sides of the front engine together, to prevent these stresses, was a cure that was worse than the disease, on account of the narrowness of the triangular or three-point support.

The sketch on the preceding page shows what happened to the spring rigging on some 2-8-8-2 engines. Some of these had the springs tilted in the direction shown and some in the opposite direction, and the condition caused serious difficulty.

It should be noted that when the springs have assumed this position they tend to remain so, on account of the difference in length of the lever arms "A" and "B."

W. E. JOHNSTON.

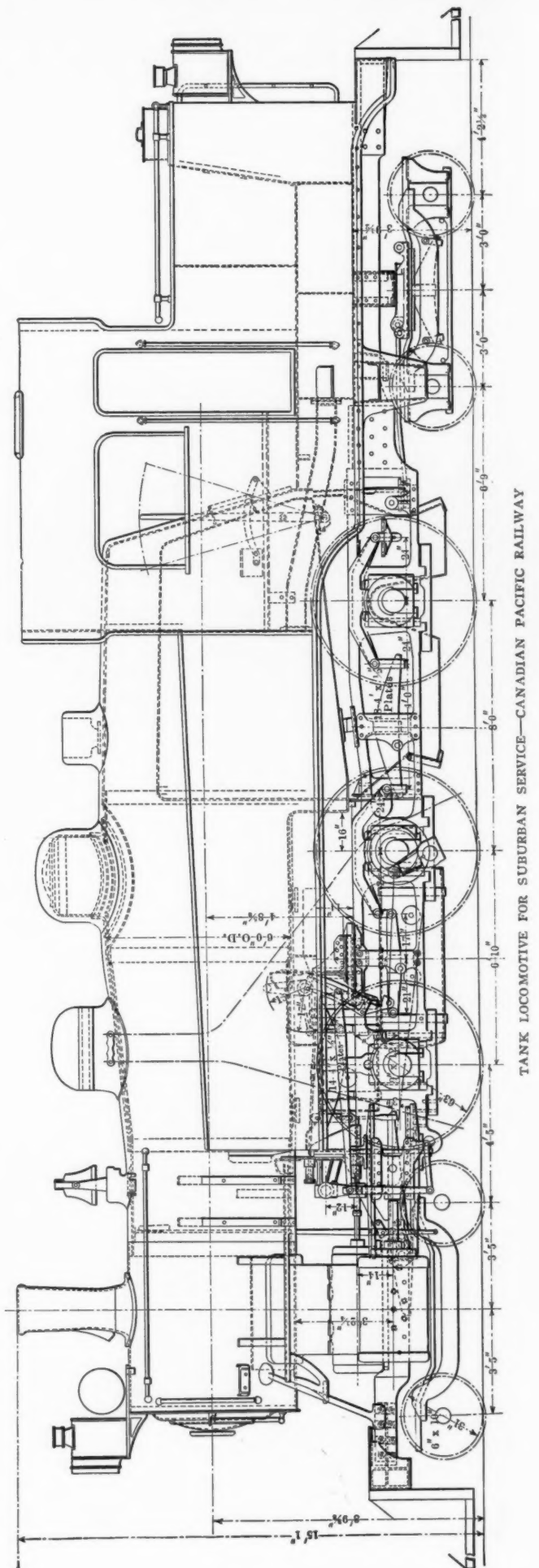
**PARTING OF THE WAYS.**—We take it for granted that every Traveling Engineer before he accepted the position has agreed with himself that he has come to a parting of the ways, a peaceable and self-respecting parting however, and we do not believe it possible for any one, we care not how honest he may be, to do justice to himself or any one else if he tries to look with one eye at the men and with the other one at the officials. Either one or the other of his eyes will be badly strained in the course of time and eventually both will become useless.—*From Committee Report at the Traveling Engineers' Convention.*

**SUCCESS OF THREE-PHASE LOCOMOTIVES IN THE SIMPLON TUNNEL.**—At the Simplon tunnel the trains are handled very smoothly by the Brown-Boveri three-phase locomotives. They run about forty miles per hour through the single-track tunnel, thirteen miles long with an up-grade each way to the middle. The overhead construction is simple, and in the yards outside of the tunnel the support is a light frame work of two-inch gas-pipe. Clean and agreeable as is the tunnel compared with others where steam locomotion is used, yet it is a poor substitute on a pleasant day for the beautiful trip over the Simplon Pass by the road built by Napoleon a century ago. This route, however, takes from seven o'clock in the morning until four in the afternoon instead of twenty minutes by the electric trains.—*Chas. F. Scott in the Electric Journal, October.*

**RECORDING STEAM METER FOR UNIVERSITY OF ILLINOIS.**—The General Electric Company has presented the University of Illinois with a recording steam meter, a device which has been in successful use as a means of determining the quantity of steam passing any pipe to which it may be attached (See *American Engineer*, September, 1910, page 377). The gift was transmitted on behalf of the General Electric Company by its Sales Manager, F. G. Vaughan, to Professor Ernst J. Berg, in charge of the Department of Electrical Engineering. This is the second significant gift that this company has made the University during the past year, the first consisting of a 100-kilowatt Curtis steam turbo-generator which now constitutes a part of the equipment of the Department of Electrical Engineering.

**NUMBER OF LOCOMOTIVES EQUIPPED WITH SUPERHEATERS.**—Recent published reports are to the effect that there are now over 800 engines equipped with superheaters on twenty railroads in North America and the number is increasing almost daily.

**MECHANICAL CONVENTIONS TO BE AT ATLANTIC CITY.**—At the annual meeting of the Railway Supply Manufacturers' Association, Washington, D. C., Sept. 30, it was decided to hold the next association meeting at Atlantic City, June 14 to 21, 1911, during the sessions of the M. M. & M. C. B. Associations.



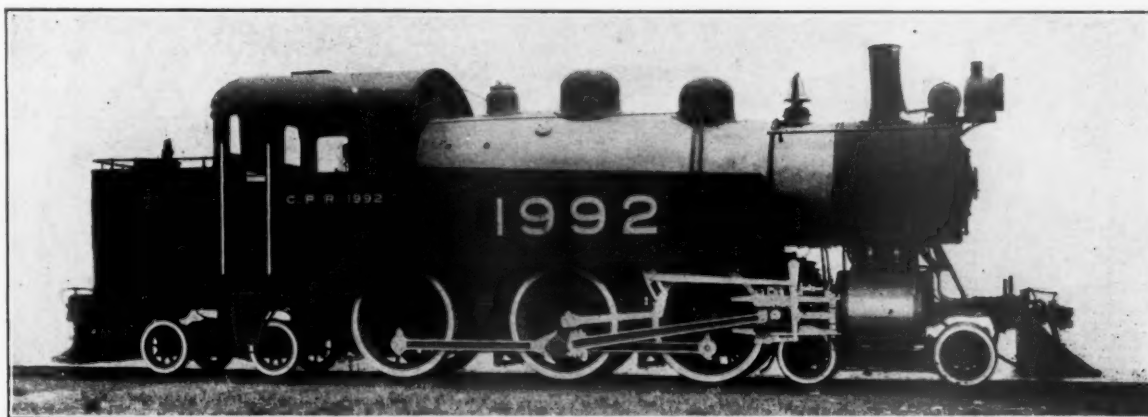
# Suburban Tank Locomotive 4-6-4 Type

CANADIAN PACIFIC RAILWAY.

An attractive appearing suburban locomotive is an unusual sight, but by careful attention to this feature the motive power department of the Canadian Pacific Railway has developed a design which in addition to amply filling the requirements of the service, presents a really attractive appearance, as is evident from the illustrations shown herewith.

Two of these locomotives were turned out of the Angus shops some time ago and have proven to be most successful. They are designed to handle trains between the Windsor Street Station and Point Fortune, a distance of 47 miles. The average train con-

and still keep its weight within the limits of the bridges, it was necessary to give every detail of the whole design the most careful study to obtain sufficient strength with the least possible weight. This has resulted in the use of structural steel shapes and steel plates for building up many of the brackets, braces and cross ties which are usually made of cast steel. With this method it has been possible to obtain a locomotive having 20 x 26 in. cylinders; 63 in. drivers; boiler with an equivalent heating surface of 2,350 sq. ft., a tank with a capacity of 3,000 gallons of water, and space for 4 tons of coal, the total weight being but



SUBURBAN TANK LOCOMOTIVE. DESIGNED AND BUILT BY THE CANADIAN PACIFIC RAILWAY.

sists of six coaches and one baggage car, and there are seven regular and thirteen flag stops west bound and four regular and twelve flag stops east bound. The schedule times are 120 and 105 minutes respectively. Coal and water is taken at Rigaud, 40 miles from Montreal. For the three months ending July 14 these two locomotives in this service made somewhat of a coal record, the consumption for that time being 345 lbs. per thousand ton miles and 79 lbs. per locomotive mile. For suburban service this is certainly a most satisfactory result.

In order to obtain the capacity desired with a tank locomotive

236,000 lbs. in working order. This including, of course, about 13,000 lbs. of water and 4,000 lbs. of coal.

A number of the parts formed of structural steel are shown in the illustrations. Among these will be noticed the link bearing cross tie, which also forms a saddle for the tanks, as well as a frame brace. This is composed of a vertical member of  $\frac{7}{8}$  in. steel plate secured to a horizontal member of  $\frac{5}{8}$  in. steel plate. There is also a horizontal stiffening plate of  $\frac{1}{4}$  in. thickness and other stiffening angles and connections arranged as the illustration shows.

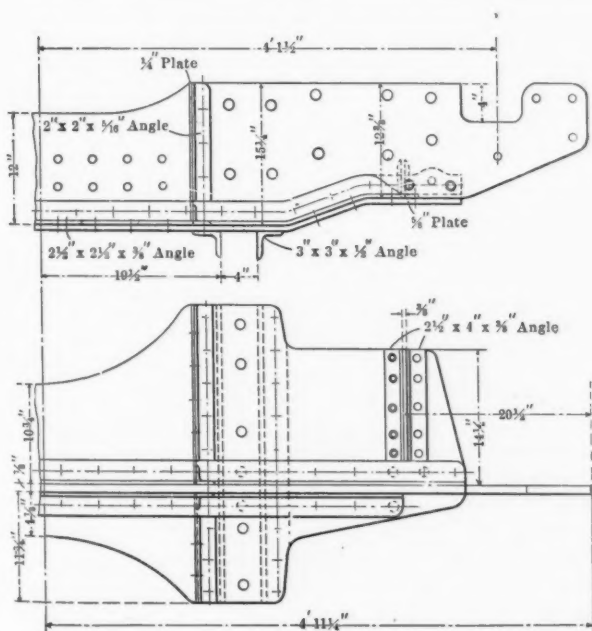
The tanks are carried from the  $\frac{7}{8}$  in. plate by  $\frac{1}{4}$  in. expansion plates and are braced by  $\frac{1}{4}$  in. gusset plates. This cross tie has a  $31\frac{3}{4}$  in. bearing on the frames and is secured to them by  $3 \times 3 \times \frac{1}{2}$  in. angles, one on either side of the frame.

As the tanks are secured to the boiler at its front end and the whole construction of tanks and crossties are riveted and bolted together both to boiler and frames, it forms an absolutely solid support for the link;

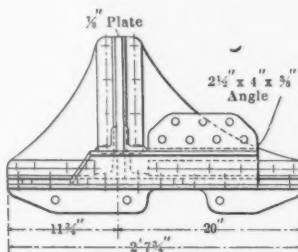
in other words, the tank has been made to reinforce the crosstie, and resists the thrust of the link.

Other structural steel details are the rear engine truck crosstie, front and back bumpers, expansion brackets, etc. The rear engine truck crosstie is composed of a  $\frac{3}{4}$  in. plate, braced by two  $\frac{3}{8}$  in. plates riveted to it, a check for the frame fit on each side was obtained by machining down a 1 in. plate to form the horizontal member. The rear bumper outside the frame is made only sufficiently strong to take push pole thrusts, but between the frames, where the pilot coupler is attached, it is strongly braced by 1 in. plate. There is a 15 in. channel facing which extends out to the sides of the back tank and has  $\frac{3}{8}$  in. top and bottom cover plates which braces it strongly together.

The front bumper which will have to withstand cornering



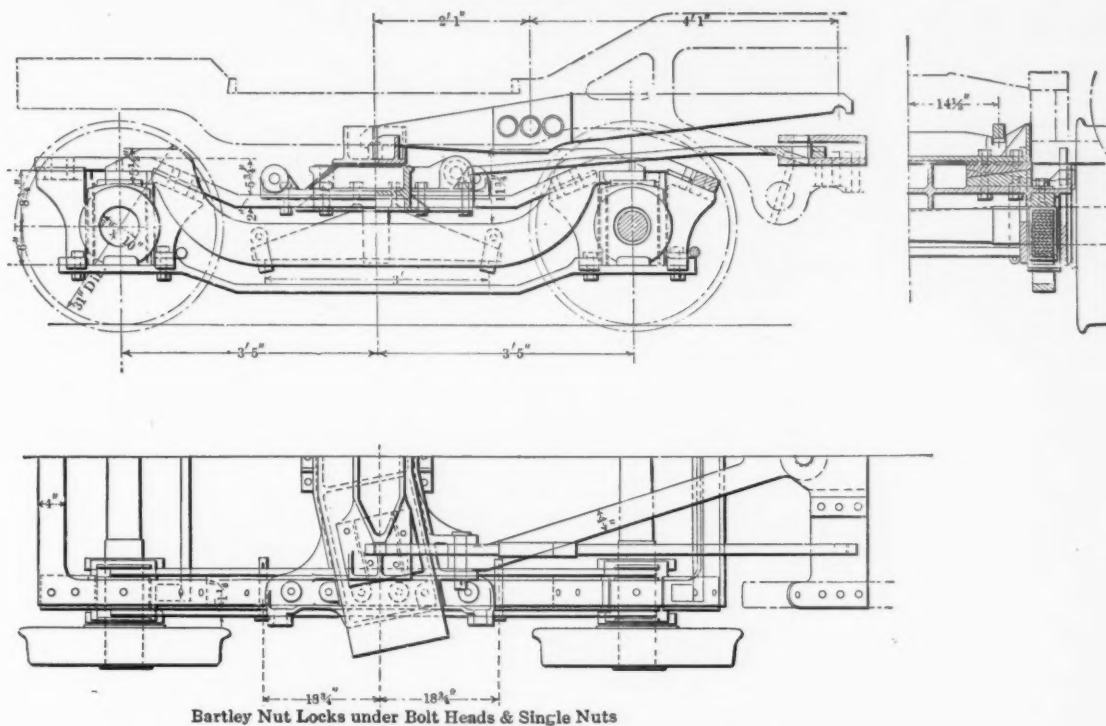
LINK BEARING CROSSTIE AND TANK SUPPORT, BUILT OF STEEL PLATES AND ANGLES.





thrusts and also protect the cylinders is of a much stronger construction than the rear. There is a 15 in. channel facing, but the top and bottom cover plates have been made  $\frac{1}{2}$  in. thick and strongly reinforced by  $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$  in. steel angles. There is a steel casting between the frames which backs up the draw-

$9\frac{3}{8}$  in. long. All of the side stays underneath the front tanks are flexible and a new system of cross braces for the roof sheet has been used. There are 8 of these braces,  $1\frac{1}{2}$  in. diameter, connected to the roof sheet by  $5 \times 3$  in. tees, so located as to prevent bulging of the roof, which reaches a maximum at a



FRONT ENGINE TRUCK.—C. P. R. SUBURBAN LOCOMOTIVES.

head and also has flanges to which the top and bottom cover plates are bolted.

The front tanks, cab and rear tank are built up together in such a way as to be continuous from front to back, and, as the front tank is secured to the boiler at a point just back of the cylinders where there is no expansion, which means that it is rigid with the main frame, and, as the rear tank and cab construction is solidly braced to the frames, the boiler does not expand, carrying the cab back with it, as with the usual construction, but is free to move backward between the front tanks into the cab, although supporting at the same time the weight of the rear end of the front tanks. This has been arranged by making the front plate of the cab  $\frac{1}{4}$  in. thick and reinforcing it by a  $3 \times 3 \times \frac{3}{8}$  in. angle which rests on top of the boiler and extends outward on each side to bolt to a lug on the top of each side tank. This angle is not studded to the boiler, but rests on a smooth filling strip on its roof sheet to permit of free movement without putting any strain on the cab front or tanks.

Both tanks and cab are of the usual plate construction, strongly braced, the tanks have a system of splash plates so arranged as to effectively break up any surge of water from end to end. The top of the front tank is in line with the top of the rear tank on which the filling hole is located and two 7 in. equalizing pipes connect them together.

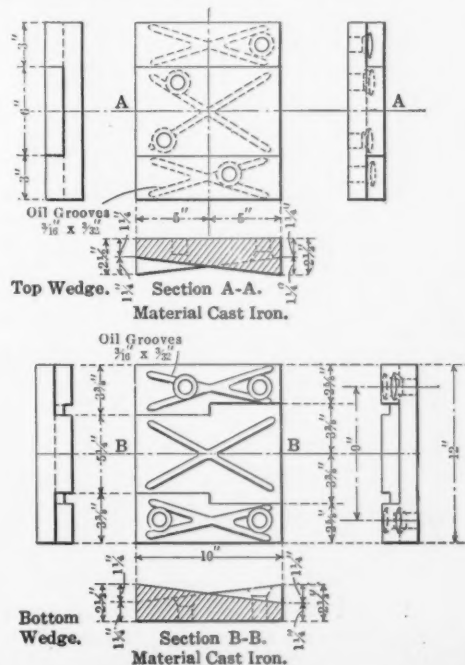
**Frames.**—Cast steel main and front frames are in one piece and the rear frame of wrought iron are let into a machined fit  $1\frac{1}{2}$  in. deep and bolted on by 11 bolts  $1\frac{1}{8}$  in. diameter. Through the use of Walshaert valve gear it was possible to liberally cross-brace the frames. At the front is the front bumper casting followed by the cylinders, guide yoke and yoke sheet, link bearing cross-tie and waist sheet, front expansion brackets and plate, back expansion brackets and plate, rear engine truck cross-tie and back bumper. The back tank itself is also built down to the frame and secured to it by two  $3 \times 3 \times \frac{3}{8}$  in. steel angles, and, as the bottom of the tank is supported by two crossbars of  $\frac{5}{16}$  in. steel plates, the whole construction is exceedingly rigid.

**Boiler.**—This is of the extended wagon top type, with medium

width firebox. There are 173—2 in. flues and 22—5 in., all 13 ft. point just above the crown. The boiler, although not strictly of the wide firebox type, has ample capacity to supply steam to the cylinders at any speed; this is shown by the "B. D." factor of 753 well within the limits of good practice.

The injector check is of the latest Canadian Pacific type\* located on top of the boiler 30 in. back of the flue sheet and is placed underneath the bell stand. The check casting proper combines the discharge from both injectors and also has a con-

\* See AMERICAN ENGINEER, Nov., 1909, page 427.



SLIDING CENTERING PLATES ON ENGINE TRUCK



ever been used by this road, and the difficulty of slack between the crosshead and bars has entirely disappeared since the adoption of this style of renewable shoe.

**Superheater and Smokebox.**—Single, adjustable draft pipes are used with a 5½ in. exhaust nozzle and 14½ in. taper stack, draft through the 5 in. tubes which contain the superheater is controlled by an automatically operated damper which cuts it off when steam is not being used. Considerable difficulty is experienced with operating cylinders in general and experiments are now being made as to what would be the action of the fire on the superheater pipes if the damper cylinder and automatic damper were omitted altogether.

A throttle of an ordinary type arranged to take steam at the top and having no drifting valve is employed.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge .....	4 ft. 8½ in.
Service .....	Suburban
Fuel .....	Bit. Coal
Tractive effort .....	28,100 lbs.
Weight in working order .....	236,000 lbs.
Weight on drivers .....	135,000 lbs.
Weight on leading truck .....	49,340 lbs.
Weight on trailing truck .....	51,660 lbs.
Wheel base, driving .....	14 ft. 10 in.
Wheel base, total .....	38 ft. 10 in.
RATIOS.	
Weight on drivers ÷ tractive effort .....	4.80
Total weight ÷ tractive effort .....	8.40
Tractive effort × diam. drivers ÷ heating surface .....	753.00
Equivalent heating surface ÷ grate area .....	71.00
Firebox heating surface ÷ total heating surface, % .....	8.65
Weight on drivers ÷ equiv. heating surface .....	57.40
Total weight ÷ equiv. heating surface .....	100.00
Volume both cylinders, cu. ft. ....	9.50
Equiv. heating surface ÷ vol. cylinders .....	248.00
Grate area ÷ vol. cylinders .....	3.48
CYLINDERS.	
Kind .....	Simple
Diameter and stroke .....	20 × 26 in.
VALVES.	
Kind .....	Piston
Diameter .....	12 in.
WHEELS.	
Driving, diameter over tires .....	.63 in.
Driving journals, diameter and length .....	0 × 12 in.
Engine truck wheels, diameter .....	.31 in.
Engine truck, journals .....	.6 × 10 in.
Trailing truck wheels, diameter .....	.31 in.
Trailing truck, journals .....	.6 × 10 in.
BOILER.	
Style .....	Wagon Top
Working pressure .....	200 lbs.
Firebox, length and width .....	114 × 41¾ in.
Firebox plaets, thickness .....	¾ & ½ in.
Firebox, water space .....	F. 4, B. 3, S. 3½ in.
Tubes, number and outside diameter .....	22—5, 17½—2 in.
Tubes, length .....	13 ft. 9¾ in.
Heating surface, tubes .....	1,045 sq. ft.
Heating surface, firebox .....	156 sq. ft.
Heating surface, total .....	1,801 sq. ft.
Superheater heating surface .....	366 sq. ft.
Equivalent heating surface .....	2,350 sq. ft.
Grate area .....	38.1 sq. ft.
Smokestack, diameter .....	14½ in.
Smokestack, height above rail .....	181 in.
Center of boiler above rail .....	104¾ in.
TANKS.	
Water capacity .....	3,000 gals.
Coal capacity .....	4 tons

### PROPOSED USE OF THERMAL UNITS AS THE MEASURE OF BOILER POWER\*

For over thirty years engineers and engineering teachers have been apologizing for the use of the term "boiler horsepower." Even the committee of the society which reported in 1884 says: "It cannot properly be said that we have any natural unit of power for rating steam boilers." If a horse power is the rate of doing work, and a boiler is considered as a machine, and the water as the moving parts, the only mechanical power that a boiler produces is that due to the external latent heat of evaporation, except when it explodes. Hence the term "boiler horsepower" is a misnomer. The object of the use of a boiler is the absorption of the heat energy obtained from the potential energy of the fuel by combustion, and its transfer to and storage by a volatile liquid for convenient use in a heat engine, or for other thermal purposes. Hence as a boiler uses the latent heat energy of the fuel as its source of power and develops and delivers

available heat energy, there would seem to be every reason why the power or ability of a boiler to deliver energy should be measured in thermal units, as being the only unit of energy that the boiler ever normally receives or delivers. Furthermore, the energy from every boiler is always measured in heat units before being reduced to boiler horsepower.

To measure the capacity or power of a boiler plant, or its output of energy, in millions of thermal units would not be practical; a smaller unit is desirable. It is therefore proposed to measure the power or capacity of a boiler in "boiler powers," and to define a boiler power as 33,000 B. T. U. of heat energy delivered per hour by a steam boiler, steam main, or by a hot-water heating main, or the like, or added per hour to the feed water of a boiler, or to the water of a hot-water heating system. The acceptance of this term will, it is thought, simplify the whole subject; the unit will remain constant, will be easily remembered and easily used, and will not be one of three standards, differing slightly among themselves, as is at present the case with the term boiler horsepower. Its analogy to mechanical horsepower will be helpful rather than the opposite, especially to the beginner in engineering knowledge. The unit boiler horsepower may still be retained by those who may prefer to use it in some one of its many thermal values.

### FAST RUN WITH A SUPERHEATER LOCOMOTIVE ON THE LONDON AND NORTH-WESTERN RAILWAY

A test run was made recently on the London and Northwestern Railway with Mr. Bowen Cooke's new 4-4-0 simple "George the Fifth," equipped with the Schmidt system of superheating, has produced some very interesting data which well illustrates the high speed possibilities of a locomotive when so equipped and intelligently handled. It is intended that the tests will be of a competitive nature between the "George the Fifth" and a non-superheater, the "Queen Mary," both engines being identical in every respect, with the exception that the latter has one inch less cylinder diameter. The comparative performance of the two engines under the same conditions has not as yet been reported, but that of the "George the Fifth" is not lacking in individual interest.

The principal dimensions of this engine are as follows:

Cylinders .....	20 × 26 in.
Driving wheels .....	.81 in.
Driving wheel base .....	.10 ft.
Boiler diameter, outside .....	.60¾ in.
Firebox, length and width, outside .....	.88 × 49 in.
Total heating surface .....	1,849.6 sq. ft.
Steam pressure .....	175 lbs.
Weight of engine in working order .....	133,540 lbs.
Weight of tender in working order .....	82,880 lbs.

The train was composed of:

Thirteen eight-wheel coaches .....	722,960 lbs.
Dynamometer car .....	76,160 lbs.
Total weight of engine, tender and train .....	454.24 tons

The distance from Crewe to London is 158 miles, and on the south-bound, or "up" trip, a stop was made at Rugby. The mean speed from Crewe to Rugby was 53¾ miles per hour, and from Rugby to London, 58¼ miles per hour. On the non-stop return trip the high average of over 60 miles per hour was attained, the actual running time being 157 minutes for the 158 miles. With this train the maximum speed reached 78½ miles per hour, 5 miles better than on the up trip. The highest indicated horsepower noted during the round trip was 1,229¼.

It is intended that the "Queen Mary" shall alternate in exactly the same service, and the tests will be continued, fairly and impartially, until sufficient data has been gathered to practically decide the superheat question on the London and Northwestern. It is interesting, however, to note in this connection that although the trial runs are unfinished, Mr. Cooke is building nine additional engines of the "George the Fifth" class and eight new 4-6-2 tank engines, all of which are equipped with superheaters.

THE CHILEAN GOVERNMENT has 1,677 miles of railway completed and 1,346 miles under construction, while private interests have 1,920 miles completed and 106 under construction.

\* From a paper by Prof. W. T. Magruder, of Ohio State University, before the American Society of Mechanical Engineers.